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PUBLIC HEALTH AND HYGIENE

IN CONTRIBUTIONS BY EMINENT AUTHORITIES

EDITED BY

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PREFACE.

A REMARKABLE advance has taken place, in the past few years, in the appreciation of the people and of their officials in regard to the value of public health. This growing opinion that public health is to a large extent purchasable by effort and money, and that it is worth purchasing has stimulated health authorities to develop their opportunities and to assume greater responsibilities. The best medical colleges have felt the force of this public opinion and no longer confine their teaching almost wholly to subjects dealing with the diagnosis and treatment of disease, but give thorough courses in hygiene, and its practical application in preventive medicine. The technological schools are also providing similar courses to their students who are thinking of entering the field of public health work. The great advances in our knowledge concerning hygiene and the increasing scope of public health work have led to the creation of many subdivisions and the problems and practices connected with these have become so highly technical as to require public health workers to restrict their activities to special lines. The medical officer for some time has appreciated this. Wherever the community is large enough to afford it, he has obtained the service of specialists to administer and develop the different departments. Thus it has come about that the department of health of any progressive State or large city has under the administrative head a number of bureaus dealing with such subjects as child hygiene, industrial hygiene, mental hygiene, sanitary inspection, foods, communicable diseases, hospitals, vital statistics, public health education and laboratories. Each of these divisions is placed under some specialist who has demonstrated his fitness.

The time has passed when any one person can possess the technical knowledge and personal experience required properly to direct and develop all or even several of these different branches of public health work. It is also true that few if any persons can discuss authoritatively more than one or two of these subjects. The report of the American Public Health Association on the control of communicable diseases was consulted in writing the chapter on that subject.

The writers of this book, holding the above opinions, believed that there was need of a volume in which the most important phases of hygiene in relation to public health would be presented in a practical way by specialists actually devoting themselves to the subjects treated by them. The writers have kept in mind that the book is intended for public health officials, physicians and medical students, and each has therefore tried to make his section as practical as possible and to utilize to the full his own personal experience. For this reason it has been impractical in most instances to give credit for the original sources of information embodied in the articles.

No attempt has been made in this volume to treat the subjects of public health law and administration as these do not fall within its scope. Other subjects more or less related to public health have been omitted because of the necessity of drawing the line somewhere in order not to increase too greatly the size of the book.

The editor was assisted in the early development of the book by Dr. Caroline E. Rosenberg. She was called away to service in Europe and since then he has been helped by Dr. Edward H. Marsh who has also prepared the index. He wishes to express his appreciation of their help.

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New York, 1920

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PRACTICAL HYGIENE.

CHAPTER I.

RELATION OF MICROÖRGANISMS TO DISEASE.

By WILLIAM H. PARK, M.D.

The great majority of persons born under civilized conditions would enjoy health and live to old age were it not for the invasion of their bodies by the pathogenic minute unicellular organisms. It is natural, therefore, at the very start to consider their characteristics and the reaction of the body to their attack.

In the production of disease by microörganisms there are four main factors involved, viz., on the part of microörganisms, the power to elaborate in the body poisons or proteins that may be split by ferments to yield poisons and the ability to multiply in the cells and fluids of the tissues; on the part of the cells of the body, the degree of sensitiveness to the poisons of the microbe, and the tendency of the cells which have absorbed the poisons to develop substances which neutralize similar poisons or attack the invading bacteria or protozoa.

No known variety of microörganisms has, in small numbers, the ability to produce enough poison to do appreciable injury in the body.

To understand the germ factor in the production of disease we must recognize the fact that both the body cells invaded and the parasitic cells which invade them are living organisms, and that the products of the cellular activity of the body act on the microörganisms at the same time their products act upon the human cells. Just as there are different races and species of animals having dissimilar characteristics, there are different races and species among bacteria and protozoa. The descendants of both under changing conditions gradually become diverse. In fact, the rapidity of the development of new generations of the unicellular organisms allow in them of much quicker changes under new conditions than are possible in the higher animals and plants. Considering these and other facts, we can readily appreciate how the different types of the microörganisms do not grow equally well in every variety of animal, and after discovering that there are variations in the properties of the blood from day to day we are not surprised that they do not find the body of the same animal always equally suitable. The study of bacteria in the more simple and known conditions of artificial culture media has shown how extremely sensi-

tive many bacteria are to slight chemical and other changes. It has also been found that conditions which are favorable to multiplication may still be unfavorable for the production of toxins or poisons.

For each variety of bacteria there are special conditions requisite for growth, and a temperature, degree of acidity, kind of food, supply of oxygen, etc., suitable for one may be utterly unsuitable for another. Moreover, when two organisms grow together one may so alter some of these conditions as to render unsuitable ones suitable, and *vice versa*.

The pathogenic protozoa or the parasitic forms are few in numbers compared with the total number of protozoa. They exert their harmful action mainly mechanically or by the direct destruction of the special host tissue which they find suitable for food. That they may produce specific toxic substances has been demonstrated in only two instances. But though in general no specific toxins have been shown to exist in protozoan forms, or to be excited by them, the fact that there is spontaneous recovery from various protozoan infections and that a reinfection does not take place soon after, indicates that some specific toxins or substances are formed which help to produce immunity. Infection through protozoa is often accomplished by means of the lower animals acting either as intermediary hosts or as direct carriers of the virus.

Adaptation of Pathogenic Bacteria and Protozoa to Certain Tissues.—Parasitic microörganisms have gradually adapted themselves not only to certain species of animals, but to certain circumscribed areas of the body. Thus, the diphtheria bacilli grow chiefly upon the mucous membrane of the respiratory tract, but cannot develop in the blood or in the subcutaneous tissues. The cholera spirilla develop in the inflamed intestinal mucous membrane, but cannot grow in the respiratory tract, blood or tissues. The tetanus bacilli develop in wounds of the subcutaneous tissue but cannot thrive on the intestinal mucous membranes or on the blood. The malarial parasites on the contrary develop in the human body, chiefly in the red blood cells.

Some microbes find certain regions especially suitable for their growth, but under conditions favorable for them are capable of developing in other locations. Thus, the typhoid bacillus grows most luxuriantly in Pyer's patches and mesenteric glands, but also invades the blood, spleen and other regions. The tubercle bacillus often remains localized in the apex of a lung or a gland for years, but may at any time invade many tissues of the body. The gonococcus finds the mucous membrane of the genito-urinary tract most suitable for its development, but also frequently is capable of growth in the eye and peritoneum and sometimes in the general circulation. The pneumococcus develops most readily in the lungs, but also invades the connective tissues, serous membranes and the blood. The malarial protozoa grows not only in human red cells, but also in the cells of the stomach and salivary glands of the mosquito.

Most of these germs, although ordinarily increasing only in the body of man, can be grown on suitable dead material. There are a few

unicellular organisms which, insofar as we know, find the bodies of human beings or animals the only fit soil for their growth. These are called strict parasites.

Adaptation of Microbes to the Soil upon Which They Grow.—Those organisms which grow both in living and dead substance vary from time to time as to their readiness to develop in any one medium or other. As a rule, bacteria grown in any one medium become more and more accustomed to that and other media more or less analogous to it, while, on the other hand, they are less easily cultivated on media widely different from that in which they have developed.

Manner in Which Microörganisms Produce Injury.—Microörganisms produce serious mechanical injury only when they exist in such enormous numbers or are bunched together so as to interfere mechanically with the circulation of the blood or, together with fibrin, cause minute thrombi, and later emboli, which finally produce infarction and abscesses in different parts of the body. The injurious effects are almost wholly due to the chemical substances contained in the germ, which are directly poisonous or after being split by ferments. Some portion of the protoplasm of almost every variety of bacteria combines with some of the substance of the body cells, and acts as an irritant to the tissues.

The poisonous products can often be separated from the fluid in which the organisms have grown, or they can be extracted from the microbes. Injected into animals these products cause essentially the same cellular lesions as are produced by the organisms when they develop in the animal body. The substances contained in or produced by the organisms, with few exceptions, attract the leukocytes, and when great masses of bacteria die suppuration usually follows. The same properties undoubtedly exist also in the poisons developed from or by the protozoa.

Influence of Quantity on Infection.—With pathogenic microbes the number introduced has an immense influence upon the probability of infection taking place. If a few bacteria are introduced into a culture medium containing some fresh human blood or serum, they will probably all die because of the presence of sufficient bactericidal substance in the blood to destroy them; whereas if a greater number is introduced there will be at first a great diminution of these—those dying which have combined with the bactericidal substances in the serums that neutralize them—and thus the bacteria which survive begin to increase and soon multiply enormously. The same is true of the parasitic bacteria in the body. A few only gaining entrance, they may die; a larger number being introduced, some may or may not survive; but if a still greater quantity gains entrance, it is almost certain that, unless the individual is immune, there will be some surviving members which will begin to proliferate and excite disease.

Variations in Degree of Virulence Possessed by Microbes.—Microbes differ as to the ease and rapidity with which they grow in any nutritive substance, as already stated, and also in the amount

of poison they produce. Both of the properties not only vary greatly in different members of the same species, but each variety of organism may be to a large extent increased or diminished in virulence. The septicemic class of bacteria when grown in the body fluids seem gradually to develop power to elaborate protective substances in their own bodies or produce cells with less substance having affinity for the bactericidal substances of the blood, and thus become less vulnerable.

With those bacteria whose virulence is great, a very few organisms will produce disease almost as quickly as a million, allowance only being made for the short time required for the few to become equal in number to the million. At the other extreme of virulence, however, many millions may have to be introduced to permit of the development of any of the organisms in the body.

Distinct, again, from that class of bacteria which multiply rapidly are those like the tubercle and leprosy bacilli which, while readily developing infection, increase more slowly. Here increase of virulence is shown, as before, by the production of disease through the introduction of very small numbers into the body, but increase in rapidity of development cannot progress except to within certain limits. A single streptococcus may, through its rapid multiplication produce death in eighteen hours; a single tubercle bacillus, on the other hand, cannot produce sufficient numbers in less than two weeks.

Experimental Increase and Decrease in Toxicity and Virulence.—The power to produce toxin and to infect animals can be taken from microbes by growing them under adverse circumstances, such as cultivation at the maximum temperature at which they are capable of development, some microbes being easily attenuated, and others being robbed of their virulence only with great difficulty. Increase of virulence is more difficult and only possible to obtain to a certain extent. The means usually employed are the frequent passage of the culture through animals. The streptococcus from erysipelas and the pneumococcus from pneumonia are typical of this class of organism. With other cultures increase in virulence does not take place. The same increase can be noted when septic infection is carried in surgical or obstetrical practice from one human being to another.

Mixed Infection.—The combined effects upon the tissues of the products of two or more varieties of pathogenic microbes, and also of the influence of these different forms on each other, are of great importance in the production of disease. The infection from several different organisms may occur at the same time, or one may follow the other or others—so-called *secondary infection*. Thus, an abscess is often due to several forms of pyogenic cocci. If a fresh wound is infected from such a source the inflammation produced will probably be caused by all varieties present in the original infection. Peritonitis following intestinal injury must necessarily be due to more than one variety of organism. Whenever two or more varieties of bacteria are transferred to a new soil, *mixed infection* is said to take place if more than one of these is capable of developing in that locality.

Forms of infection which are both secondary and mixed infections are those occurring in the mucous membrane of the respiratory and digestive tract. In these situations pathogenic microbes of slight virulence are always present, even in health. Thus, in the air passages there are usually found streptococci, influenza bacilli and pneumococci. When through the invasion of one or several infective agents, as the diphtheria bacillus or the virus of smallpox or scarlet fever, the epithelium of the mucous membrane of the throat is injured or destroyed, the pyogenic cocci already present are now enabled in this diseased membrane to grow, produce their poisons and even invade deeper tissues. The intestinal mucous membrane is invaded in a similar way by the colon bacilli and other organisms after injury by the typhoid or dysentery bacilli or cholera spirilla. Generally speaking, all inflammations of the mucous membranes and the skin contain some elements of mixed infection. Blood-infection, on the other hand, is usually due to one form of bacteria, as even when several varieties are introduced, only one as a rule is capable of development. The same is true to a somewhat less extent of inflammations of the connective tissue. The additional poisons given off by the associated microbes aid infection by the primary invaders by causing a lowering of the vital resistance of the body. In some cases the secondary infection is a greater danger than the primary one, as pneumococci bronchopneumonia in laryngeal diphtheria, lobar or bronchopneumonia in influenza, or streptococcic septicemia in scarlet fever and smallpox.

Microörganisms are also at times directly influenced by the products of associated organisms. They may affect them injuriously as, for example, the pyogenic cocci in anthrax; or they may be necessary to their development, as in the case of anaërobic bacteria. Tetanus bacilli or spores, for instance, would not be able to develop at times on wounds were it not for the presence of aërobic bacteria introduced with them. Again, it is found that the association of one variety with another may increase its virulence. On the other hand, the absorption of the products of certain bacteria immunizes the body against the invasion of other bacteria, as shown by Pasteur, that attenuated chicken-cholera cultures produce immunity against anthrax. In intestinal putrefaction harmless varieties of bacteria may be made to crowd out dangerous ones.

Tissue Characteristics Influencing the Entrance and Growth of Microbes.—The Skin.—The skin is a poor soil for bacteria and is a great protection against the penetration of microörganisms. When they do penetrate, it is through some unobserved wound. The bacterial toxins are, when at all, but slightly absorbed through the skin.

An apparent exception to the above exists in the fact that the pyogenic staphylococci and sometimes the streptococci are found upon the skin or in it between its superficial cells, exceptional circumstances such as wounds or burns being required to allow the organisms to penetrate deeper. The cutaneous sweat-glands and the hair follicles

with their appended sebaceous glands, may also permit the entrance of infection through various incidents leading to the introduction and retention of virulent organisms.

Subcutaneous Connective Tissue.—Many microbes cannot develop in the connective tissue and others produce a milder infection there than elsewhere. Some develop rapidly. The tissue fluids have bactericidal properties similar to but less in amount than the blood.

The Mucous Membranes.—The moist condition of the surface of the mucous membranes and their frequent contact with irritating substances render them liable to microbal infection. Organisms, such as the pneumococci and streptococci reproducing themselves in it, become somewhat attenuated; the mucous membranes are protected by the cleansing action of the flow of the secretions and by its slight germicidal effect. In infancy the mucous membranes are readily infected by gonococci and later by pneumococci and other bacilli. The mucous membranes of the nasal cavity are also somewhat cleansed by the flow of the nasal secretions. The deeper portions of the nasal cavity are usually the seat of streptococci and other bacteria, while the extreme anterior portions contain saprophytic bacteria from the air. The mouth of a person in health is cleansed by the feebly bactericidal effect of the saliva. When the teeth are decayed many varieties of bacteria abound. The bacteria, such as the diphtheria bacilli, streptococci, etc., seldom invade the mucous membrane of the mouth or tongue. The tonsils with their crypts are usually the seat of the pyogenic cocci and are readily infected with the diphtheria bacilli and others.

The Lungs.—Most inhaled organisms which pass the larynx are caught in the bronchi. Many of these are gradually removed by the ciliated epithelium. Both the alveoli epithelial cells and the leukocytes which enter the air cells and bronchioles have been shown to take up bacteria. The normal lung is, therefore, rapidly freed of saprophytic and many parasitic bacteria. When subjected to deleterious influences, such as exposure to cold, the lung tissues may lose their protective defences and become subject to infection.

The Stomach.—The pure gastric juice, through the hydrochloric acid it contains, is able to kill most non-sporebearing organisms in a short time, but because of neutralization through food, or because the microbes are protected in the food, many of them pass into the intestines. Tubercle, typhoid, colon and dysentery bacilli, when fed by the mouth with food, readily pass beyond the stomach. Perforation of the stomach is usually followed by peritonitis, because of the irritant effect of the gastric juice and the bacteria which were temporarily present in the stomach. The gastric juice alters tetanus and diphtheria toxins. The toxicity of some poisons, such as the botulinus toxins, is not destroyed. The stomach is exceptionally free from bacterial inflammations.

Intestines.—The bile is feebly germicidal for some organisms, but on the whole, the intestinal secretions have little or no germicidal

power. The number of microbes increases steadily from the duodenum to the head of the colon, and diminishes slightly from the upper to the lower end of the colon. The pancreatic juice destroys many of the toxic microbal products. The presence of the bacilli of the colon group of streptococci, etc., does not often lead to any inflammatory condition in the normal intestines of healthy persons. In children suffering from the prostrating effects of heat they are apt to excite inflammatory changes. Even pathogenic bacteria such as the typhoid, dysentery and tubercle bacilli, may pass through the whole length of the intestines without inciting inflammations. Slight lesions aid the passage of bacteria to the deeper structures. Tubercle bacilli and other pathogenic bacteria may pass through the intestinal wall to the lymph and cause distinct infections without leaving any trace of their passage. Non-pathogenic protozoa are frequently found in the intestines, and, in tropical conditions, pathogenic forms are also found.

Importance of Location of Point of Entry of Organisms.—Most microbes cause infection only when they gain access to special tissues and must, therefore, enter through certain portals. This fact is of immense importance in the transmission or prevention of disease. Thus, for example, let us rub very virulent streptococci, typhoid bacilli and diphtheria bacilli into an abrasion in the hand. The typhoid bacilli produce no lesion, the diphtheria but a very minute infected area, but the streptococci may give rise to a severe cellulitis or fatal septicemia. Now place the same bacteria in an abrasion in the throat. The typhoid bacillus is again harmless; the diphtheria bacillus produces inflammation, a pseudomembrane and toxemia and the streptococcus causes an exudate, an abscess or a septicemia. Finally, introduce the same bacteria into the intestines, and now it is the typhoid bacillus which produces its characteristic lesions, while the streptococcus and diphtheria bacillus are usually innocuous.

If we tried in this way all the parasitic organisms in turn we would find that certain varieties are capable of developing and thereby exciting disease only on the mucous membrane of the throat, others of the intestines, others of the urethra; some develop only in the connective tissues or in the blood; while others, again, under favorable conditions, seem able to grow in or upon most regions of the body.

Dissemination of Disease.—The spread of infection is influenced by: (1) The number of species of animals subject to infection; (2) the quantity of the infectious material and the manner in which it is thrown off from the body; (3) the resistance of the infectious organism to the deleterious effects of drying, light, etc.; (4) the ability or lack of ability to grow outside of the infected tissues; and (5) germ carriers.

The Number of Species of Animals Subject to Infection.—Many human infectious diseases do not occur in animals, and many animal infections are not found in man. Thus, so far as we know, gonorrhea, syphilis, measles, smallpox, typhoid fever, etc., do not occur in animals under ordinary conditions; while tuberculosis, anthrax, glanders, hydrophobia, and some other diseases are common to both man and animals.

The Quantity of the Infectious Material and the Manner in which it is Thrown off from the Body.—In diphtheria, typhoid fever, cholera, pulmonary tuberculosis, septic endometritis, influenza and gonorrhea, enormous numbers of infectious bacteria are cast off through the discharges from the mouth, intestines and genito-urinary secretions, causing great danger of infection. On the other hand, in tuberculous peritonitis, streptococcus meningitis and endocarditis, gonorrheal rheumatism, and the like, there is no danger of infection to others, as no bacteria are cast off.

The Resistance of the Infectious Organism to the Deleterious Effects of Drying, Light, Etc.—In this case the presence or absence of spores is of the greatest importance. The spore-bearing bacilli, such as tetanus and anthrax, being able to withstand destruction for a long time, retain their power of producing infection for months or even years after elimination from the body. The bacteria which form no spores show great variation in their resistance to outside influences. Some of them, such as the influenza bacillus and the gonococcus, the virus of syphilis and hydrophobia, are extremely sensitive; the pneumococci, cholera spirilla, glanders bacilli, etc., are a little hardier; then follow the diphtheria bacilli, and after them the typhoid and tubercle bacilli and the staphylococci. Yeasts, moulds and protozoa produce resisting spores, which, however, are not as highly resistant as most bacterial types.

The Ability or Lack of Ability to Grow Outside of the Infected Tissues.—Such bacteria as the pneumococcus, tubercle, influenza, diphtheria, glanders and leprosy bacilli do not develop, so far as we know, outside of the body under ordinary conditions. Under exceptional circumstances, as in milk, some may develop. Others, again, such as the streptococcus, typhoid and anthrax bacillus, the cholera spirillum, and some anaërobes, may develop under peculiar conditions existing in water or soil.

Germ Carriers. (*a*) *Human Carriers.*—In human carriers microorganisms develop in or upon some portion of the skin or mucous membrane, either after or before disease, and without infection. As complete a knowledge as possible of this saprophytic development in man of parasitic microbes is necessary if we are to combat the spread of infection. In the superficial layers of the epithelium and on the surface of the skin we find the different pyogenic cocci, which are capable of infecting a wounded or injured part or causing inflammation of the glands. Acne, the pustules in smallpox, the pus on a burned surface, boils, etc., all come from these pyogenic cocci. In surgical cases the skin has to be as thoroughly disinfected as possible to prevent the formation of stitch-hole abscesses and wound infection.

In the secretions of the mucous membranes covering the pharynx and nasopharynx there is always an abundance of microbes. In experiments carried out in New York City, streptococci and pneumococci were found in almost every throat, and even in the country they were often present. In the anterior nares there are

fewer parasitic bacteria than in the posterior portions. Many other varieties of bacteria such as the meningococci and the influenza bacilli are probably often present in smaller numbers. In those constantly in contact with cases of diphtheria, and in those convalescent from diphtheria, virulent bacilli are frequently found in the throat. After convalescence from typhoid fever, from 1 to 3 per cent. remain bacillus carriers for months or years. The bacilli continue to develop in the bile passages and are passed with the feces. Certain pathogenic protozoa may be carried for some time in the intestines of man.

(*b*) *Lower Animals.*—The lower animals, as a rule, do not retain in their bodies bacteria pathogenic for human beings, but as direct carriers of bacterial infection they are important factors. Fleas and other insects may convey organisms which are simply attached to their feet or other surfaces of their bodies. Biting insects, especially, such as fleas, ticks, bed-bugs, lice, flies and mosquitoes, are a source of danger in protozoan infections more particularly, since these insects act as intermediate hosts in these cases.

Microbal Auto-infection.—When the intestinal canal is impaired or its circulation hindered by strangulation, etc., the colon bacilli and some other bacteria may penetrate through the injured walls and cause peritonitis or general infection. Under certain conditions as in the debility due to hot weather, the bacteria in the intestines may cause through their products irritation, and in children even serious intestinal inflammation. Long after an acute gonorrhea has passed gonococci may remain in sufficient numbers to cause a new inflammation or produce infection in others. A cystitis may run on chronically for years, and then suddenly become acute or spread infection to the kidneys. A persistant gonorrheal vaginal infection may lead to a gonorrheal endometritis or peritonitis or salpingitis under suitable conditions. The staphylococci in the skin and the colon bacilli and pyogenic cocci in the fecal discharges may also be carried into the bladder and uterus and produce septic infection. Persons carrying diphtheria bacilli in their throats or typhoid bacilli in their gall-bladder may, under predisposing conditions, develop diphtheria or typhoid fever.

In nearly all cases of infection the products of bacterial growth are absorbed into the blood, and along with them a few bacteria also, even when they do not reproduce themselves in it. The greater the extent of the infection and the more deep-seated it is, the greater is the amount of absorption.

When bacteria are abundant in the blood they become fixed in the capillaries of one or all of the organs, especially of the liver, kidneys, spleen and lungs, and then directly or by means of the leukocytes, which penetrate the capillary walls, they pass into the tissues and substance of the organs. They thus reach the lymph channels and glands, or gain entrance into the gall-bladder, saliva, etc., or pass through the epithelium, as in the alveoli of the lungs; more rarely they pass through the kidney tissue into the urine, as in typhoid fever.

Some of the More Important Microbal Poisons.—Toxins.—Any poisonous substance formed in the growth of bacteria or other microorganisms is loosely called a toxin, but in the strict sense this term should be confined to the extracellular poisons, as these alone have the important characteristic of causing the cells of the body affected by them to produce antitoxins.

The different bacterial poisons vary greatly in their characteristics, though little is known about their chemical nature except that they are proteins. They may be divided into two groups: (1) Extracellular toxins; (2) intracellular toxins. Under extracellular toxins are included those varieties of bacteria that excrete in ordinary culture media water-soluble, very specific toxic products. Type: bacilli of botulism, diphtheria, tetanus. These alone produce toxins. Under intracellular toxins are included those varieties of bacteria which possess toxic protein substances which are more or less closely bound to the living cell, and which are only in a small degree separable in a changed condition outside of the body. Type: the bacteria causing cholera, typhoid, etc. These are sometimes called endotoxins. Some of these substances are only poisonous when split up by specific ferments present in the serum or cell fluids.

Extracellular Toxins.—The properties of the extracellular toxins are as follows: They are, so far as we know, uncrystallizable, and thus differ from ptomains; they are soluble in water and they are slowly dialyzable, through thin membranes but not through thick membranes such as are used in refining antitoxins; they are precipitated along with peptones by alcohol and also by ammonium sulphate; if they are proteins they are either albumoses or allied to these; they are relatively unstable, having their toxicity diminished or destroyed by heat and freezing as well as by chemical manipulation. Their potency is often altered in the precipitation practised to obtain them in a pure or concentrated condition, but among the precipitants ammonium sulphate has but a moderate harmful effect. A remarkable characteristic of the group is that they are highly specific in their properties and have the power in the infected body to excite the production of antitoxins. The diphtheria and tetanus bacilli are the best known extracellular toxin products.

Intracellular Toxins.—Regarding the intracellular toxins which are more intimately associated with the bacterial cell and are produced by all bacteria, very much less is known. They are apparently proteins, and it is probable that their chemical action is somewhat similar. They do not produce antitoxins. These bacterial proteins may be poisonous originally, or only when split by ferments.

Ptomains.—Organic bases of a definite chemical composition have been isolated from putrefying fluids, meat, fish, old cheese and milk, as well as from pure bacterial cultures (Neuchi, Breyer, Vaughan). Some of these have been found to exert a poisonous effect, while others are harmless. The poisons may be present in the decomposing cadaver—hence the name ptomain from the Greek for putrefaction—

and consequently have to be taken into consideration in questions of legal medicine. They may be formed also in the living human body, and if not made harmless by oxidation, may come to act therein as self-poisons or leukomains. These substances possess the characteristics of alkaloid bodies and are different from the specific toxins.

Many ptomains are known and among these are some whose exact chemical composition is established, such as cadaverin, cholin and muscarin, separated from decomposing dead bodies and cholera cultures.

The ptomain tyrotoxicon has been obtained from cheese, milk and cream.

Pyocyanin, which produces the color of blue or blue-green pus, is a ptomain pigment. Similar bodies of a basic nature may be found in the intestinal contents as the products of bacterial decomposition.

Since the name ptomain was given to the poisonous products of bacterial growth before these products were chemically understood, it is by many wrongly applied to all poisons found in food. Such poisoning is usually due to true toxins or living germs.

Similar Vegetable and Animal Poisons.—Substances similar to those classed as bacterial endotoxins (intracellular toxins) and as soluble toxins are formed by many varieties of cells other than bacteria. The ricin and abrin poisons obtained from the seeds of the Ricinus communis and the Abrus precatoria have a number of properties similar to those of the diphtheria and tetanus poisons. When injected into suitable animals antipoisons are produced and accumulate in the serum. These neutralize the poisons wherever they come in contact with them. They resemble the toxins in a general way in the manner in which they react to heat and chemicals. They are precipitated by alcohol. Through animal membranes they are less dialyzable than albumoses. Substances having these characteristics are called toxalbumins.

Poisonous snakes secrete poisons which have many of the characteristics of the bacterial albumoses. The venom contains some substances similar to peptone and others similar to globulin. The former cause general nervous symptoms and paralysis of the respiratory center, while the latter cause intense local reaction with hemorrhages around the point of injection. The injection of venom into animals is followed by the production of antivenins which neutralize the venins. When the serum containing abundant irritable antivenom is injected into an infected person it has considerable therapeutic value.

The pyogenic action of their proteins is common to all microbes, this depending principally upon their being extraneous albuminous substances. Pyogenic effects may be produced in like manner by extraneous albumins of non-microbal origin.

Specific Responses of the Body.—When the filtrate of a seven-day-broth culture of the diphtheria bacillus is injected in sublethal doses into animals, for instance the horse, the cells react with the production of an antibody against the toxin. This substance is called "antitoxin." Its production is shown by the fact that increas-

ing doses of the toxin can be injected till hundreds or thousands of fatal doses can be given without causing death. Likewise, it can be shown that mixing the blood or serum of the horse with toxin will result in neutralization of the toxin. This neutralization follows a multiple scale, thus if one part of serum will neutralize one part of toxin, one thousand parts of serum will neutralize one thousand parts of toxin.

In the filtrate of a seven-day-broth culture of the typhoid bacillus the antibodies produced are practically all antibacterial. Although the filtrate may be toxic, we find that the size of successive doses can be increased but not to any extent comparable with that noted above. After the horse has received a series of injections the serum will neutralize the toxic action of the typhoid bacillus protein to some extent but such neutralization will not follow a multiple scale. As the amount of "endotoxin" is increased the multiple of serum required will have to be much greater. If the amount of "endotoxin" is still further increased neutralization becomes impossible however much serum is added. If further tests are carried out it will be found that the antibodies produced are dominantly antibacterial in character. That is, the antibodies are antiprotein in character, the bacillus substance stimulating their production.

The mechanism underlying recovery, therefore, in all infections is essentially antibacterial in character, that is the development of specific antibacterial antibodies and their action as well as that of the phagocytic cells. Acquired immunity through infection is in most instances essentially antibacterial in character.

Another phenomenon is intimately associated with the process of recovery as well as with the development of immunity, viz., hypersensitiveness or anaphylaxis. This is made use of for diagnostic purposes as is the use of tuberculin in tuberculosis and mallein in glanders.

There are no demonstrable differences in the phagocytic cells themselves before and after the acquisition of active immunity. That is, an acquired increased phagocytic power of the cells does not play any part in active immunity. There may be present, however, an increased number of those antibodies which act as an aid to phagocytosis.

Summary.—Neutral resistance to invasion by bacteria is due to some extent to the protective covering of the physiological exterior of the body as well as to the protective action of the secretions which are discharged on these surfaces. Neutral resistance or immunity to infection may exist because of the possession of antibodies as well as because of the activities of the phagocytic cells. A natural immunity may be specific in which case the immunity is essentially antibacterial in character. Such an immunity is only relative. In the case of diphtheria a natural antitoxic immunity may exist which is complete. Infection causes a more or less marked increase in antibacterial antibodies which are apparently

essential in the recovery from disease. Phagocytosis likewise is an important factor in such recovery. An acquired immunity through infection or artificial inoculation by microörganisms which do not produce an extracellular toxin, is probably also dependent upon the stimulus to the development of specific antibacterial antibodies. In both the mechanism of recovery of disease and of acquired immunity, sensitization of the cells to bacterial products is an important factor. An acquired antitoxic immunity develops after infection in only a small proportion of cases. It can be produced in nearly all susceptible persons through inoculation.

Cellular Activity of Antibodies.—It is evident in the light of the large amounts of antibodies that might be produced in response to the injection of small amounts of toxin, that the antibodies were secreted by the body cells and were not due to a conversion of bacterial products.

The antibodies have been found to be a globulin-like substance and because the proteins of one species of animal are foreign bodies in another it is found that the antibodies produced by the horse are retained a much shorter time after introduction in man or other animals than others transferred to another horse. Thus an injection of tetanus antitoxin gives immunity in the injected horse of some months' duration, while in man immunity is only certain for from ten days to three weeks.

Theories Concerning the Production and Action of Antibodies.—It was soon evident to early investigators, especially in the light of the large amounts of antibodies that might be produced in response to the injection of small amounts of toxin, that the antibodies were secreted by the body cells and were not due to a conversion of bacterial products.

On this basis Ehrlich elaborated his well-known "side-chain theory." This theory was first advanced in the attempt to explain the nutritive process of cells. He conceived the cell as consisting of a complex central chemical nucleus of relatively constant structure to which the cell owed its peculiar functional character. Attached to this are many "side chains" which because of their affinities can take the appropriate food molecules from the body fluids. After such combination the food molecule is assimilated and incorporated in the central nucleus. This conception places the nutritive activities on a chemical basis. When infection occurs the toxins or other products combine with the cell by the same mechanism if there is an affinity between any of the side chains and the molecules of toxin or other microbal product. These products may find suitable side-chain, "receptors or haptines," in many varieties of cells or in only the cells of certain tissues or organs. When the microbal products combine with the side chains the molecules are available not simply as foodstuffs but are actually deleterious and the side chain or receptor is destroyed; or, if sufficient receptors are involved the central nucleus is injured and dies. When the nucleus lives the receptors are regenerated. In this regeneration, however, the concep-

tion of overproduction as advanced by Weigert comes into play: that is, the injury not only stimulates the regeneration of the destroyed receptors but an excess of these receptors. The cell possessed of more recep-

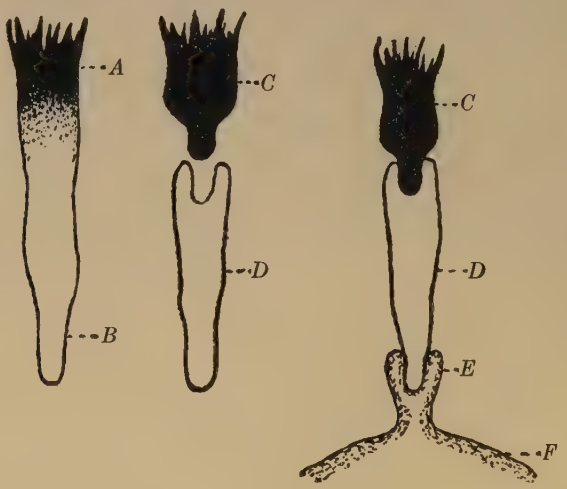


FIG. 1.—Graphic representation of receptors of the first and third orders and of complement as conceived by Ehrlich: *A*, toxophorous group of toxin; *B*, haptophorous group; *C*, complement; *D*, intermediary or immune body; *E*, foreign cell receptor; *F*, part of cell. *A B* unites directly with *E; C* unites by means of *D*.

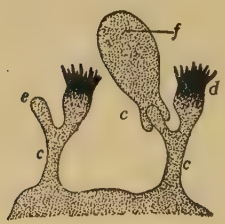


FIG. 2.—Receptors of the second order. Here *e* represents the haptophore group, and *d* the zymophore group of the receptor, *f* being the food molecule with which this receptor combines. Such receptors are possessed by agglutinins and precipitins. It is to be noted that the zymophore group is an integral part of the receptor.

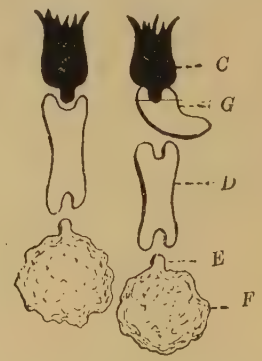


FIG. 3. — Graphic representation of amboceptors or receptors of the third order and of complement, showing on left the immune body uniting complement to foreign cell and on right the action of anti-complement, binding complement and so preventing its union with the ambocepter. *C*, complement; *D*, immune body; *E*, receptor; *F*, foreign cell; *G*, anticomplement.

tors than necessary for its nutritive process casts the excess off into the body fluids, these cast off receptors now constituting free antibodies.

It is conceivable that if the stimuli to the cells were continued by the repeated partial destruction of receptors, large amounts of antibodies would be found in this way. The theory explains the general specific character of the antibodies as only those cell receptors are overproduced which have an affinity for the products of the infecting organism. The very bodies that when connected to the cell "sessile" made possible the poisoning of the cell, constitute the antibodies when free.

Bordet has shown that toxin unites in different multiples with antitoxin, so that the toxin molecule may have its affinity slightly, partly or wholly satisfied by antitoxin. If slightly satisfied, it is still feebly toxic; if combined with a larger amount of antitoxin it is not toxic, but still may, when absorbed into the system, lead to the production of antitoxin. If fully satisfied it has no poisonous properties and no ability to stimulate the production of antitoxin.

CHAPTER II.

ANTIMICROBAL OR ANTIPROTEIN SUBSTANCES INDIVIDUALLY CONSIDERED.

By WILLIAM H. PARK, M.D.,
AND
CHARLES KRUMWIED, Jr., M.D.

AGGLUTININS.

By the phenomenon of agglutination is meant the aggregation into clumps of microörganisms uniformly dispersed in a fluid. If the organisms are motile they become immobile during this process. Many substances other than those in serum cause the agglutination of cells.

This phenomenon (agglutination), while it had been noted by earlier observers (Charrin and Roger in 1889), was first extensively studied by Gruber and Durham in 1896, who determined that the serum of those passing through certain infections contained a specific substance (agglutinin) which caused the infecting organisms to clump. Several months later Widal reported that in typhoid fever the development of agglutinins could be used for diagnostic purposes. It was thus demonstrated by these studies and those of Grunbaum, Bordet and others that through agglutinins a new means was available for the identification of bacteria and in many cases the nature of the infectious organism causing disease.

Agglutinogen.—The antigenic substance stimulating the production of agglutinins is called the agglutinogen. It is formed in the living or dead microbal cell and appears to be released in cultures only on the dissolution of the organism. Heat and chemicals tend to destroy or alter agglutinogenic action. According to the Ehrlich hypothesis we may look upon the agglutinogen as a protein molecule having a haptophore group through which it combines with the cell receptor. (See Fig. 2.) Evidence has been advanced that the agglutinogen is contained in the ectoplasmic portion of microörganisms.

Mechanism of the Agglutination Reaction.—Agglutination is not a vital phenomenon. The microörganisms play a purely passive role.

The observations of Bordet showed very definitely that agglutination was a physical phenomenon and that the combination of antigen and antibody was one phase, and agglutination another. Thus if a suspension of bacteria and a sample of serum be dialyzed until all salts are removed their mixture will not result in agglutination, unless salt be added. Or if the dialyzed mixture be centrifuged to remove the bacteria, and the sedimented bacteria suspended in salt solution agglutination will promptly occur. If sufficient bacteria have been used the super-

natant fluid is free of agglutinins as shown by the absence of agglutination when salt and fresh bacteria are added. In other words combination occurs in absence of salts by agglutination only in their presence or, otherwise stated, agglutination is a clumping of the bacterium-antibody complex by salt action. These observations led to a comparison of the agglutination phenomenon to the flocculation of one colloid by another and the flocculation of colloids by salts and acids (electrolytes).

Measurement of Agglutinins or Titration of an Agglutinating Serum.—The agglutinating power of a serum is measured by determining the highest dilutions in which it still exhibits this quality. The titer of the serum as commonly used implies the highest dilutions in which complete agglutination still occurs. The results may be stated in another way, the titer is the smallest amount of serum which will agglutinate an arbitrarily selected standard amount of culture. The titer will vary according to the three factors, density of suspension, temperature of incubation and time of incubation. The denser the suspension the more agglutinins will be required. Agglutination proceeds relatively more rapidly as the temperature is raised from 20° to 55° C. The reaction may be observed under the microscope, "microscopic method," or by the eye using test-tubes or slide "macroscopic methods" (see below, Technic of Agglutination Reactions).

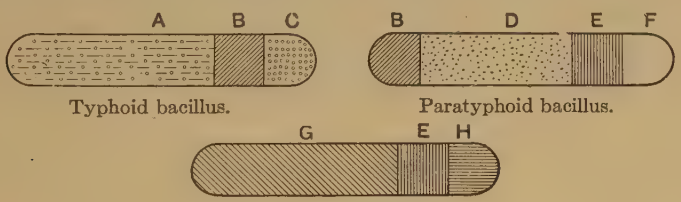


FIG. 4.—Specific and common agglutinins producing protoplasm.

Specific (Major) Group and Normal (Minor) Agglutinins.—Allied species of bacteria have protein substances that are more or less similar (Fig. 4). If these common substances stimulate the production of agglutinins, the relative amount of each agglutinin should be somewhat proportional to the amount of agglutinogenic protoplasm possessed by the infecting or injected microörganism. Thus a serum from a typhoid patient may agglutinate B. typhosus in dilutions of 1 to 160, B. paratyphosus, 1 to 20, B. coli, not at all. The specific or major agglutinins should be present in greatest amount because the greatest stimulus is given by the preponderance of the specific typhoid protein, the group, common or minor in proportionately less amounts. This parallelism is not always followed, thus the serum from a case of paratyphoid fever may agglutinate B. typhosus as well as or even better than the infecting type. Likewise, the serum of an animal injected with B. paratyphosus B. may agglutinate a related but distinct bacterium, B. choleræ suis, as well as the homologous bacterium. Several

factors influence the relative production of major and minor agglutinins, especially the duration of the agglutinogenic stimulation, that is, the duration of the infection or the number of injections in the case of artificial immunization. The following chart serves as an example. Evidently the longer the period the greater is the probability of the production of considerable group agglutinins (Fig. 5).

Another factor is the nature of the host. Thus the rabbit, as a rule, produces less group agglutinins than does the goat, whereas the horse produces very large amounts of common agglutinins. There is a relationship between the production of group agglutinins and the degree to which agglutinins are normally possessed by the host. Normal agglutinins having group activity may be present for several or many varieties of bacteria. Thus the serum of man frequently agglutinates the typhoid or colon bacillus in dilutions of 1 to 1 or even 1 to 5.

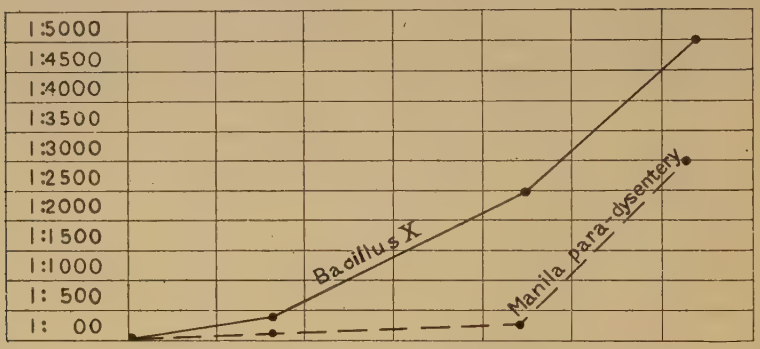


FIG. 5.—A young goat was used for the injection of the colon bacillus X. The great accumulation of common agglutinins for the paradysentery bacillus in the third month of the injections of bacillus X is very striking.
● Tests made.

The serum from a normal horse may agglutinate these types in dilutions of 1 to 100 or 1 to 1000 or even more. The possession of such agglutinins we may assume to be due partly to the reaction to the continued absorption of intestinal bacteria of the colon group. Such an explanation, however, does not explain the fact that normal horse serum usually agglutinates the glanders bacillus in dilutions of 1 to 500 to 1 to 1000 or more, depending on the method used.

Possession of normal agglutinins in the species most commonly employed for the production of agglutinating serum is relatively as follows: rabbit, slight or absent; goat, moderate; horse, high to very high. This parallels, as above noted, the degree of group agglutinin production. If the varieties of normal agglutinins are carefully tested the paradoxical results obtained with some immune sera become clearer. Thus a horse serum may contain before injections a high content of agglutinins for two bacteria, B. dysenteriæ and B. coli.

Absorption of Agglutinins.—This method advanced by Castellani allows us to differentiate with accuracy between specific and group

agglutination. The specific agglutinins and also the common agglutinins which are stimulated by the infecting or injected bacterium should be bound by the homologous organism; in other words, if we add to a serum a large amount of its specific organism and then incubate we shall find that the clear serum obtained by centrifuge or filtration will no longer agglutinate either the specific organism or any of the related types previously agglutinated through the action of the group agglutinins. If we absorb similarly the serum with a related type we find the specific agglutinins will not be appreciably reduced, whereas the group agglutinins for the absorbing strain will have partly or wholly disappeared. Examples with moderate and extreme group agglutination are shown in the following tables:

ABSORPTION OF AGGLUTINATING SERUM OBTAINED BY INJECTION OF B. TYPHOSUS.

	Highest dilution giving complete agglutination before absorption.	Absorbed by B. typhosus.	Absorbed by B. coli.
B. typhosus . . .	1 to 5000++	1 to 50−	1 to 4000++
B. coli	1 to 1000++	1 to 50−	1 to 50−

ABSORPTION OF AGGLUTINATING SERUM OBTAINED BY INJECTION OF B. PARATYPHOSUS B.

	Agglutination before absorption.	Absorbed by B. paratyphosus "B."	Absorbed by B. choleræ suis.
B. paratyphosus B. .	1 to 10,000++	1 to 50−	1 to 8000+
B. choleræ suis . . .	1 to 10,000++	1 to 50−	1 to 50−

Absorptive results are susceptible to serious misinterpretation if character of the serum before immunization, especially the content in normal agglutinins be not known.

Absorption results are of value only when we possess, or know, the specific type which caused the infection or was injected. Thus the fact that B. typhosus removes all the agglutinins from a patient's serum both for B. typhosus and B. paratyphosus, whereas the latter only removes them for itself, is no guarantee that B. typhosus is the infecting bacterium. The infection may be due to a third related but unknown variety, the absorption results being group agglutinin absorption. Likewise, given a serum from which B. typhosus and B. paratyphosus will only completely remove the agglutinins for themselves is no certain proof of the existence of a mixed infection. The infection again may be due to a third unknown bacterium, the absorption resulting only in the removal of individual varieties of group agglutinins.

Dead bacteria agglutinate well, although somewhat more slowly, if killing is done by the addition of 0.25 per cent. carbolic acid or preferably 0.1 per cent. formalin. If killed by heat the temperature should not exceed 55° C. Heating to 60° C. diminishes their agglutinability.

Dreyer found that if a twenty-four-hour bouillon culture of B. coli required 1 part of agglutinin to agglutinate it, then if heated to 60° C.

it required 2.3 parts; if to 80° C., 18 parts; if to 100° C., 24.6 parts. He found the surprising fact that long heating of the culture restored to some extent its ability to be agglutinated by smaller amounts of agglutinins. Heated thirteen hours to 100° C. the culture was agglutinated by four parts.

The Development of Agglutinins.—Appreciable agglutinins do not develop until toward the end of the first week of infection, and the agglutinin content tends to rise if infection continues, reaching its acme at the height of the disease or somewhat later. Animals show the development of agglutinins in about the same length of time after immunization is begun. Each successive injection tends to stimulate the production of further agglutinins until a considerable concentration is present.

Different varieties of microörganisms vary in their agglutinogenic capacity. Thus the typhoid-paratyphoid group have a high agglutinogenic value, the streptococcus-pneumococcus group a relatively low power. Infection by members of the former causes a relatively high agglutinin content, whereas infections by the latter cause the production of only a relatively low agglutinin content. The same result is obtained after intensive immunization of animals, an antityphoid serum giving agglutination in dilutions of thousands or tens of thousands being easily obtained, whereas an antipneumococcus serum agglutinating above 500 to 600 is only exceptionally produced.

The amount of infection or injected antigen bears a relative proportion to the amount of agglutinins produced.

Practical Applications of the Agglutination Reaction.—The agglutination reaction controlled by agglutination absorption is the method employed for the determination of the identity of culturally similar microörganisms. By this means we have determined, for instance, that all races of B. typhosus are alike; that is, that B. typhosus is a distinct type or entity. In this connection it is worthy of note that a group of bacteria may differ culturally, for instance, in their fermentative reactions and still be found to be identical agglutinatively. The agglutinative method likewise allows us to separate culturally similar members of a definite bacterial species into subgroups, an example being the pneumococcus, of which we have three distinct types, and also a large group of agglutinatively dissimilar varieties.

It is obvious that having knowledge of the kind above outlined we can then utilize the agglutination reaction to identify a definite type such as B. typhosus or determine into which subgroup a bacterium belongs, for example, the pneumococcus. With certain groups we shall know that the subgroup cannot be determined with certainty unless we employ the absorption method (meningococcus). With other species we will be satisfied with morphological or a cultural identification because we do not possess the necessary knowledge for further agglutinative identification or because the knowledge we have indicates the existence of a multiplicity of races. Finally, we may not be able to employ agglutination for identification because the bacterium (at

least most strains) does not agglutinate well or because of its character (clumping and adhesiveness, etc.) a good suspension is difficult or impossible to make (B. anthracis). In utilizing the direct method for identification the precautions are: (1) The serum employed must be of high titer to overcome the tendency to resist agglutination shown by freshly isolated strains. The serum from infected human beings is usually unsatisfactory for this purpose because the titer is much lower than that obtainable by intensive immunization of animals. (2) The range of specific and group (including normal) agglutinins must be known, that is, determined by tests using homologous and related types. (3) The unknown type must agglutinate considerably beyond the range of group action before identification is considered sufficient for practical purposes.

The reverse application, viz., the determination of the kind of agglutinins present in a patient's serum, can be utilized for the diagnosis of disease. In this method we utilize a known bacterium to identify the agglutinins. It should be clearly understood that this method by itself does not possess final or absolute value. Thus we test a person's serum and find a considerable content of "typhoid" agglutinins. Unless we have isolated an infecting typhoid bacillus we cannot prove that they are not group agglutinins, developed because of an infection by B. paratyphosus or some other similar but infrequent type. Taking the findings, however, in connection with clinical facts and our knowledge that the majority of continued fevers of typhoidal character are (in this vicinity) due to B. typhosus the presence of agglutinins becomes the strongest possible evidence of the existence of an infection due to B. typhosus. If we suspect the infection to be due to a paratyphoid type we can determine whether B. typhosus or B. paratyphosus "A" or "B" is agglutinated in higher dilutions. The presumption is that the type agglutinated in highest dilutions is the infecting type. This is only a presumption, however, as paradoxical results may occur, as we have said, due to a high group agglutinin content or oversensitiveness of one culture.

The direct agglutination reaction for diagnostic purposes has only a limited application. It can only be applied in diseases in which agglutinins are freely produced. Even here its practical value may be lessened because other simple methods are applicable earlier in the disease. Before it can be applied to a specific disease we must first determine the range of agglutinins normally possessed by uninfected individuals; knowing this we designate a minimum diagnostic dilution for a positive test. Although this method may be of little value in the early diagnosis of such acute diseases as cholera, it may be of the greatest value in making a *post facto* diagnosis. The agglutination test is chiefly used in typhoid and paratyphoid fevers. The use of the typhoid-paratyphoid vaccine creates a difficulty which can be overcome in most cases by making several careful tests. If the agglutinins are found to have increased it is certain that they are due to the occurring infection.

Technic.—The agglutination reaction may be observed in the hanging drop, using the microscope ("microscopic method"), or observed in the test-tube with the eye alone or aided by a low power lens ("macroscopic tube method"), or on a glass slide ("slide agglutination method"), a modified macroscopic method.

Technic of Microscopic Reaction (Widal Reaction).—Preliminary dilutions of the blood or serum are prepared one-half the strength of the final dilutions desired. A loop of each dilution is placed on separate cover-slips, as well as a loop of the diluent. Then at the side of each drop is placed a loop of the culture. The two drops on each slip are then mixed with the platinum wire. This results in a doubling of each of the blood dilutions. Hollow-ground slides, the edges of the concavities having been smeared with vaselin, are warmed and placed over the cover-slips so as to seal the drop in the concavity. Warming the

FIG. 6.—Microscopic field, showing the top of a hanging drop in a normal typhoid culture.

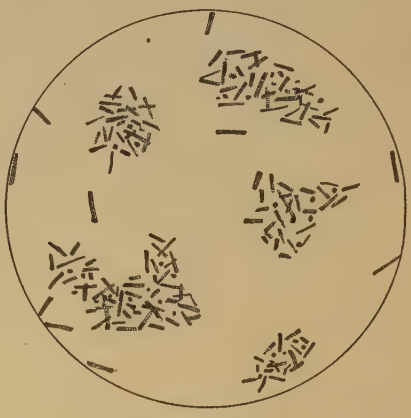


FIG. 7.—Microscopic field, showing the top of a drop with the typhoid reaction.

slides softens the vaselin so that it spreads better. The seal must be complete or the drops will dry up. The slide is then turned face up and the reaction observed under the No. 6 objective (magnification about 500 diameters). The drops must hang freely, that is, they should not be too large so that there is contact with the hollow of the slide. The drop containing diluent and culture alone is the "control." This must be carefully observed to eliminate spontaneous agglutination and as an index of the motility when a motile bacterium is employed.

A broth culture incubated for eighteen hours is usually employed in the microscopic reaction. When employed for the diagnosis of disease a "standard" "culture" is employed, that is, one of known agglutinability, otherwise the results will not be comparable. Such a culture should be one that, due to cultivation on artificial culture media, has reached a constant level of ease of agglutinability.

The beginner is apt to use too heavy a culture. The broth culture

may give more delicate and sharper results when diluted by adding sterile broth Fig. 6.

The slides may be kept at room temperature, 20° C. or at incubator 35° C. The reaction proceeds more rapidly at the higher temperature.

If the reaction is observed through the microscope in a hanging drop a formation of clumps is seen which, if it takes place rapidly, reveals the reaction almost completed at the first glance, that is, most of the bacilli are in loose clumps and nearly or altogether motionless (Fig. 7). Between the clumps are clear spaces containing few or no, isolated bacilli. If the reaction is a little less complete a few bacilli may be found moving slowly between the clumps in an aimless way, while others attached to the clumps by one end are apparently trying to pull away, much as a fly caught in fly-paper struggles for freedom. If the agglutinating substances are sufficiently present, but still less abundant, the reaction may be watched through the whole course of its development. Immediately after mixing the blood and the culture together it will be noticed that the bacilli move more slowly than before the addition of serum. Some soon cease all progressive movement, and it will be seen that they are gathering together in small groups of three or more, the individual bacilli being still somewhat separated. Gradually they close up the spaces between them and clumps are formed. According to the completeness of the reaction, either all of the bacilli may finally become clumped and immobilized or only a small portion of them, the rest remaining freely motile, and those clumped may appear to be struggling for freedom. With blood containing a large amount of agglutinating substances all the gradations in the intensity of the reaction may be observed from those shown in a marked and immediate reaction to those appearing in a late and indefinite one by simply varying the proportion of blood added to the culture fluid.

Pseudoreactions.—If too concentrated a solution of dry blood from a healthy person is employed a picture is often obtained which may be mistaken for a reaction. Dissolved blood always shows a varying amount of detritus, partly in the form of fibrinous clumps and prolonged microscopic examination of the mixture of dissolved blood with a culture fluid shows that the bacilli, inhibited by substances in the blood, often become more or less entangled in these clumps, and in the course of one-half to one hour very few isolated motile bacteria are seen. The fibrinous clumps alone, especially if examined with a poor light by a beginner, may be easily mistaken for clumps of bacilli. Again, the bacilli may become fixed after remaining for one-half to two hours by slight drying of the drop or the effect of substances on the cover-glass.

Technic of the Macroscopic Tube Method.—The suspension employed may be a broth culture or a suspension in saline of the growth from an agar slant. In the case of bacteria which autolyze easily (meningococci) the suspensions should be heated to 56° C. to destroy the autolytic ferment. Such suspensions may be preserved for future use by adding a preservative, such as 0.25 per cent. carbolic acid. The suspension

should not be too dense. A very slight clouding gives the sharpest results. Broth cultures to which 0.1 per cent. of formalin has been added make very satisfactory antigens. Prepare the initial serum dilutions 10 times more concentrated than will be the desired end dilutions. Place 0.1 c.c. of each dilution in a small chemically clean test-tube and 0.1 c.c. of saline in another for a control. To each of the tubes add 0.9 c.c. of the bacterial suspension, shake the tubes and incubate in the water-bath or incubator at 37° to 55° C.

If agglutination takes place it is shown first by a change in the appearance of the suspension. Instead of the uniform opacity there develops a ground-glass appearance. If one uses a lens one can see very fine clumps. As the reaction proceeds the clumps become more easily visible. If after incubation for two or three hours the tubes are allowed to stand, preferably in the ice-chest overnight the clumps fall to the bottom of the tube. If the reaction is complete the supernatant fluid will be clear. In settling, the agglutinated bacteria form a broad film over the bottom of the test-tube, whereas the sedimentation of non-agglutinated bacteria results in a compact button-like sediment.

The control tube should always be carefully inspected to exclude spontaneous agglutination.

Comparison of Tube and Microscopic Slide Methods.—The reaction is the same in both and one is as reliable as the other. The ice-box readings (macroscopic) are apt to be higher than those obtained by microscopic examination. For diagnostic examinations in which haste is necessary and small amounts of serum are available, as in typhoid fever, the microscopic method is preferred. When a delay of twenty-four hours is no handicap and the serum is abundant as in tests for glanders in horses the macroscopic tube-test is generally used. Dead cultures are more frequently used in the macroscopic method because the motility here is of no importance.

Dreyer Method of Macroscopic Agglutination.—The basis of this method is the employment of a standardized antigen. This makes more uniform and comparable results possible. The method was suggested primarily as a means by which the rise or fall of agglutinins could be accurately determined. Thus, Dreyer believes typhoid or paratyphoid fever can be differentially diagnosed in the vaccinated because the rise or fall of the infection agglutinins is marked within short periods, whereas the agglutinins due to vaccination will be relatively stable during a similar period. To be able to determine a rise or fall with accuracy it is obvious that a standardized antigen must be employed.

The antigen is prepared by subculturing daily in broth for about ten days. Then flasks of broth are inoculated and incubated for twenty-four hours. Add 0.1 per cent. of formalin (40 per cent. formaldehyde solution), place on ice for several days, shaking repeatedly. The culture is then standardized for opacity and agglutinability. Dilutions of the culture are compared with dilutions of a standardized culture

and the degree of greater density of the new culture determined by taking the mean of at least six successive selections of tubes of similar density. The culture is diluted accordingly with physiological salt solution containing 0.1 per cent. formalin and tested for agglutinability. This is done by comparing the results of agglutination with that obtained with a previously standardized culture. The new suspension is then given a factor of agglutinability based on comparison of the highest dilutions showing agglutination to the naked eye. The dilution of the standardized culture is to that of the new culture as the factor of the former is to that of the latter. The original standard had a factor of 1, and to make results with subsequent antigens comparable they must be corrected according to this factor.

If one possesses no standardized culture the optimum opacity may be determined by setting up agglutinations with various dilutions of the antigen and determining which gives the sharpest readings. One can always standardize back to this original antigen and can at any time transfer the results in terms of another standard culture.

Dreyer recommends incubation at 55° C. for two hours. For further details, including the methods Dreyer uses in expressing the results, reference is made to the article by Davison.[1] We have found the use of formalinized broth cultures of standardized opacity of the greatest value in carrying out extensive experimental work with members of the typhoid, paratyphoid and dysentery group. The use of agglutination antigens thus standardized is preferable in determining the curve of agglutinin response to vaccines in man or in animals, especially when the agglutinin response is used as a presumptive indication of the antigenic value of the vaccine. Exceedingly sharp readings are possible if the tubes are placed on ice overnight. The sharp results are due apparently to the sensitiveness of the antigen as well as its dilution, which results in fewer grades of intermediate reactions.

The Macroscopic Slide Method.—This method allows a rapid diagnosis of colonies from plates inoculated with suspected material, such as feces, throat cultures, etc., and can be employed in examinations for cholera, typhoid, paratyphoid and dysentery bacilli as well as for meningococci. A highly potent serum, whose specific and group agglutinating strength is known, should only be used, or false positive results will be obtained; hence the method is not of much worth in clinical diagnosis of blood.

The method is as follows: A loopful of saline solution (as control) and one of the highly potent specific serum in low dilution are placed on one slide and a sufficient amount of the suspected colony to give a slight turbidity is added to each. Flocculation begins in the serum almost at once if the organism tested is specific. A negative reaction is not exclusive, as relatively inagglutinable strains may be encountered, although with highly potent serum there is nearly always some evidence

[1] Jour. Am. Med. Assn., 1916, lxvi, 1297; also Fennel; Jour. Am. Med. Assn., 1918, lxx, 590.

of a reaction. Colonies apparently typical but not distinctly agglutinable should be fished for further identification. Colonies giving a positive reaction should also be fished for verification, unless experience has shown that the serum used does not give false positive results with allied types.

PRECIPITINS.

Precipitins are antibodies which, when added to a clear protein solution, cause a precipitation. In 1897 Kraus noted that if the serum of an animal immunized against B. typhosus is added to bacteria-free filtrates of broth cultures the mixture first became turbid, which change was followed by precipitation. Similar results were obtained with other antisera and their homologous bacteria.

Nature of Precipitins.—The properties of precipitins are very similar to those of agglutinins. They are fairly resistant, but are gradually destroyed by heating to 60° to 70° C. Ehrlich and Bordet consider the precipitin antibody as having the same structure as the agglutinins. Ehrlich classes it as an antibody of the second order. The loss of activity of precipitins according to this conception would be due to the deterioration of the more labile zymophore group, resulting in the formation of "precipitinoids." Precipitins are specific within certain limits.

Mechanism of the Precipitin Reaction.—If we look upon the precipitin antigen, that is, the clear solution of bacterial proteins as simply a suspension of invisible protein molecules as contrasted with microscopically visible bacteria in an agglutination antigen, the mechanism must be similar to that of the agglutination reaction. The known facts and theories of the mechanism of one reaction apply in general to the other.

Development of Precipitins.—Precipitins are not commonly demonstrable in the serum of infected individuals. This antibody is usually present in appreciable amounts only after prolonged and intensive immunization. The precipitinogen, that is, the stimulant to its production, may be live or dead bacteria or solutions of their proteins obtained by extraction or autolysis.

Practical Applications of Precipitin Reaction.—The precipitin reaction has only a limited application in the identification of bacteria in culture and body fluids and discharges. It is less easily applied than the agglutination reaction, because of the necessity of preparing a clear bacterial extract. Another disadvantage is that the range of precipitin action of an antiserum is relatively low. At the present the reaction is limited in practical work largely to the differentiation of the types of pneumococcus. An important application is the determination of the presence and variety of bacterial substance in excretions, exudates or lesions. Thus, in lobar pneumonia considerable soluble products of the pneumococcus are found in the lung, in the sputum, in the blood and thence in the urine. Advantage is taken of this fact by using the precipitin reaction to determine the type of infecting

pneumococcus. Likewise, if the sputum is injected intraperitoneally into the mouse the precipitin reaction may be similarly applied to the peritoneal exudate. In the case of anthrax infections in animals, extracts of the lesions frequently give a precipitin reaction with immune anthrax serum, thus permitting a diagnosis.

The precipitin reaction with the serum of the infected host, because of the absence of appreciable amounts of precipitin, has been applied practically very little in the diagnosis of disease. The serum of horses infected with glanders usually gives a precipitin reaction, and the method has been used for diagnosis. The results are less reliable than those obtained with the agglutination or other serological reactions.

The Nature of the Precipitin Antigen.—As is evidenced by the methods of preparation given above, the antigen, using this term in the narrow sense of the reacting substance, resists boiling even in the presence of acid and alkalies. In fact, its resistance is so extraordinary that it is not destroyed by boiling in strong alkaline hypochlorite solution even for one-half hour or longer. Pick also found that the precipitin antigen was not destroyed by decomposition or digestion by pepsin or trypsin. Certain data indicate the existence also of a thermolabile and alcohol-soluble precipitable fraction in bacterial extracts.

Although the substance is present in greatest amounts in broth cultures after incubation of twenty-four to forty-eight hours or longer it is demonstrable in young cultures of the pneumococcus, for instance, after four to six hours.

Other Antibodies in the Precipitate.—Agglutinins, bacteriolysins, complement-fixing substances and protective antibodies are carried down with the precipitate. These can be dissociated to some extent from the precipitate by extraction with weak alkaline solutions.

Precipitins for Other than Microbal Proteins.—Tchistovitch and Bordet showed that the injection of alien serum would result in the production of precipitins for the injected serum. Similarly, precipitins can be prepared for vegetable proteins. Further observations revealed that this reaction had species specificity, that is, the reaction occurred quantitatively highest with sera from individuals of the same species as used for injection. The degree of group reaction with sera of other species depends on the closeness of biological relationship of the species. The antiserum precipitin will react with the other albuminous secretions of the same species. By washing organs free of blood a certain degree of organ specificity seems demonstrable. One peculiar fact is worthy of note, however, the crystalline lens from fishes to man has the same protein content as determined by the precipitin reaction.

Practical Applications.—Because of the marked species specificity the precipitin reaction may be employed to identify the source of blood stains for medicolegal purposes. It is also applied in the determination of the sophistication of foods.

Given a blood stain, presumably human, the first step is to prove that it is blood. If the blood cells have disintegrated, this is done by

chemical means, preferably by the demonstration of hemin crystals. The extract of the stain in salt solution is used as the antigen in the test. In the case of meats a salt solution extract of the meat, or, for instance, sausage, is made and used as an antigen with antibeef, antihorse, antidog, etc., sera. That giving reaction in dilutions commensurate with controls of known meat gives us our result. The antisera are obtained by several large injections of the species serum into rabbits. The technic of the reaction is based on the fact that even very dilute amounts of antigen are demonstrable. The antigen is diluted, therefore, not the serum. With very potent antisera even dilutions of 1 to 25,000 or more of the antigen will give a reaction. In the cases mentioned above an estimated initial dilution of 1 to 1000 is prepared, from which other dilutions can then be made. The antigen is then floated over the serum and incubation carried out at 37° C. The appearance of a ring at the point of contact is a positive reaction. The reagents must be clear and many controls with other antisera and known antigens are necessary to exclude error. In a few attempts we have been only moderately successful in differentiating between cold storage horse meat and beef.

BACTERIOLYTIC ANTIBODIES.

In 1888 Nuttal demonstrated that normal blood had a bactericidal or bacterium-killing property without regard to the presence of phagocytic cells. He showed that serous exudates contained similar substances and found that the bactericidal action was weaker after standing and was quickly destroyed by heating to 60° C. Buchner found the same property was possessed by serum obtained after the clotting of blood and called the active substance "alexin." Pfeiffer, in 1894, showed that if guinea-pigs were first immunized against the cholera vibrio and then injected intraperitoneally with living cholera vibrios there was a rapid swelling, granulation and dissolution of the bacteria. This process could be followed by removing portions of the peritoneal exudate with capillary tubes and examining it in stained smears. A normal guinea-pig would not show this phenomenon or at most slightly, but the phenomenon could be induced even with normal pigs if "immune" serum were introduced with the vibrios. The same result occurred if the serum was first heated to 60° C. This is known as the "Pfeiffer phenomenon." The active substance, therefore, was an acquired antibody, and, as he showed, was specific, acting only on the cholera vibrio. The hypothetical substance causing this action, Pfeiffer called "bacteriolysin," or specific bactericidal substance.

Bordet then showed that the phenomenon was due to the interaction of two substances, one the specific substance, increased during immunization, which was thermostabile (50° to 60° C.). He also showed that fresh immune serum is actively bactericidal, but if this power were lost by standing or by heating it could be fully restored by the addition of

fresh guinea-pig serum which possessed little bactericidal action by itself.

The Immune Body or Amboceptor.—The terms bactericidal or bacteriolytic are used to denote whether the bacterium is only killed or killed and disintegrated. There is no evidence that we are dealing with two distinct antibodies. The term amboceptor was adopted by Ehrlich because he believed that the antibody was a cell receptor having two haptophore groups, one with an affinity for the bacterium the other for combination with the third substance normally present in serum, which he called complement.

He termed the amboceptor an antibody of the third order. They resist heating to 60° C., but are gradually destroyed by heating to 70° to 80° C. The amboceptor combines with the cell in the absence of complement. As with other antibodies, those produced during immunization have highly specific as well as some group action. They are also normally present to a varying degree, as noted above, in results obtained by Nuttal and others.

The Complement.—Complement is present in normal and in immune serum. Its quantity is not increased during immunization. It is the active substance in bacteriolysis. Its structure, according to Ehrlich, is very similar to that of a toxin possessing a haptophore group for combination with the receptor and an active or cytophile portion to which it owes its action. The latter portion is unstable, deteriorating when serum is left at room temperature for forty-eight hours or longer, and is destroyed by heating to 55° C. for one-half hour, and is very sensitive to acids and alkalis. The residual haptophore group Ehrlich terms a complementoid, and believes that it will combine with the receptor, thus preventing the action of active complement. Such evidence as is available indicates that the leukocytes are a source, if not the only source of complement. How many varieties of complement exist is an open question. Bordet believes there is only one variety, whereas Ehrlich and others have advanced what they consider evidence to prove the existence of many varieties. Complement in its action resembles ferments very closely. (See below.)

Mechanism of Amboceptor-Complement Action.—According to Ehrlich's hypothesis the amboceptor acts as a bridge for the action of complement. Bordet, however, believes that amboceptor combines with the bacterial cell, sensitizing it to the action of the complement. In favor of such a conception is the fact that complement shows little if any affinity for the immune body in the absence of the homologous bacterium. If the amboceptor were simply a double haptophore bridge the complement should combine with the amboceptor. Here, again, we find differences in theoretical considerations based on hypotheses of quantitative chemical combination or on the more physical theories of colloidal adsorption. The combination of the antigen with amboceptor and complement is approximately quantitative as with other antibody combinations. The most important variation in quantitative relationship is seen in the fact that if the amount of amboceptor is increased

less complement is needed, whereas if the amount of complement is increased less amboceptor is needed. Even though the mixtures of bacteria, its homologous amboceptor, be incubated for prolonged periods there is no evidence of proteolytic cleavage, yet the bacteria may be dissolved. The action of the complement on the amboceptor-cell complex would seem to be upon the cell envelope and stromata, making it permeable and liberating the protein content. Amboceptor and complement have different avidities in relation to temperature; thus amboceptor will combine with the bacterial cell even at a temperature just above the freezing-point, whereas complement will only combine with the cell-amboceptor complex at higher temperatures, its optimum being at 37° C., at which temperature it also displays its highest activity. Amboceptor and complement are fixed by the substances in extracts of bacteria, even in the absence of demonstrable precipitation. (See Precipitins.)

Determination of Bactericidal or Bacteriolytic Action.—The activity of a serum may be determined by *in vivo* and *in vitro* methods. The Pfeiffer phenomenon in guinea-pigs is utilized for the former. The test is carried out by injecting a series of guinea-pigs intraperitoneally with a constant amount of culture and decreasing amounts of the serum. The reaction is observed by removing portions of the peritoneal exudate to determine the degree of action. The smallest amount of serum yielding a positive reaction gives us the titer of the serum.

The test-tube method is usually carried out according to the technic of Stern and Korte. To a series of test-tubes add decreasing amounts of the inactivated (heated to 55° C. half hour) serum. To each tube then add 0.1 c.c. of fresh guinea-pig serum to supply a constant amount of complement. Add saline to bring the contents of each tube to constant amount, 0.5 or 1 c.c. To each tube add a small amount of dilute suspension or broth culture of the homologous organism. Incubate for three hours at 37° C., and then make poured agar plates of the contents of each tube and incubate and determine the relative number of colonies developing. Adequate controls must be made, a salt solution control before and after incubation, an amboceptor control of the lowest dilution without complement and of complement alone. The guinea-pig serum may be bactericidal itself. The sterility of each of the reagents must also be controlled.

It is obvious that with this method, even though we did not inactivate the serum we are titrating the amboceptor content as we are adding complement to activate the amboceptor in the high dilutions. If we wished to determine the actual bactericidal value of native serum because of its content of immune body and natural complement we should carry out the test in a similar manner employing a constant amount of fresh active serum but decreasing the dose of culture. The number of organisms in the decreasing dose may be estimated by control plating. The largest number of organisms that is killed by this constant dose of serum is the measure of the serum.

The methods are relatively difficult to carry out and unsatisfactory

results are common with the plate methods because the culture or the complement employed are not satisfactory. Reduplication or comparable results are difficult to obtain on successive tests for the same reasons. The tests are not applied practically today for purposes of identification of bacteria or as a diagnostic procedure. The Pfeiffer reaction has lost its importance as a means of identification because the simpler agglutination reaction gives us the same information.

The methods are used primarily for experimental purposes to determine the response to injection of vaccines or to compare the bactericidal action of serums with the degree of action of other antibodies.

Relation between Agglutinating and Bactericidal Power.—In spite of proof to the contrary, the belief persists that there is regularly a parallelism between the agglutinating and the bactericidal strength of a serum. In Fig. 8 are recorded a number of comparative tests during a period of sixteen months. The experiment shows no definite relation

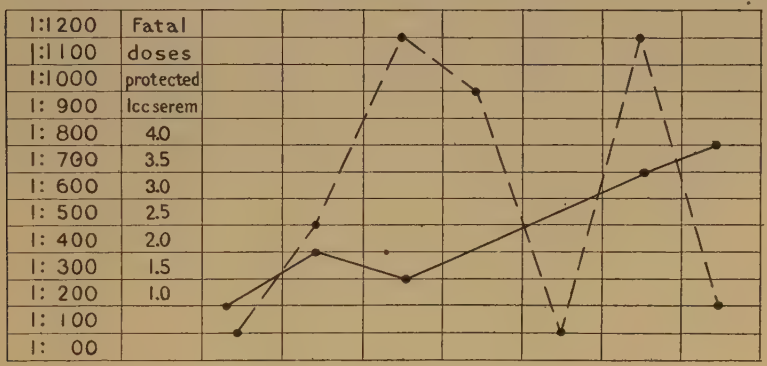


FIG. 8.—Relation of agglutinative to bactericidal power. Horse injected over a period of sixteen months.

— — — Agglutination index.

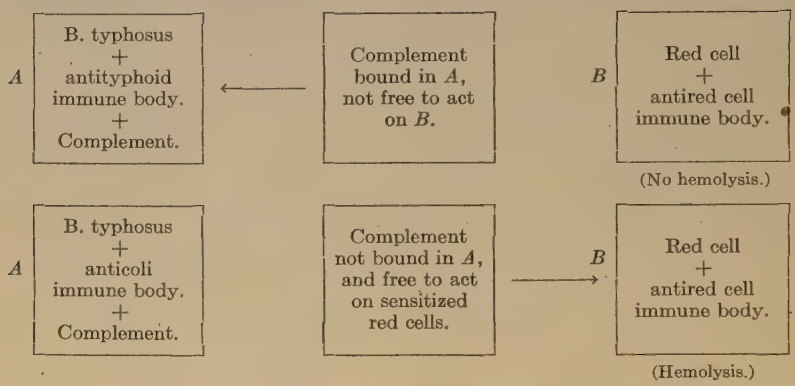
——— Bactericidal index.

● Test dates.

between content of agglutinins and immune bodies. We have found in horses subjected to injections of a fixed type of pneumococcus that the agglutinating strength increases more rapidly than the bactericidal strength and that it decreases while the latter is still increasing.

Bordet-Gengou Phenomenon or Complement-fixation Reaction.—If we take an antigen, bacterial or non-bacterial, and add to it a small amount of inactivated homologous immune serum and complement (fresh guinea-pig serum) and incubate the mixture, there will result a combination of the three elements. If we have not added too much complement none should be left free. We can determine this to be so by adding red cells which have been sensitized by incubation with their homologous antiserum. There being no complement free, no hemolysis results. If we repeat the experiment and use a heterologous antigen or a heterologous antiserum, complement should not be combined. This will be shown when we add our "complement indicator," red cell

sensitized with their homologous antigen, hemolysis quickly develops after appropriate incubation. These facts are diagrammatically represented as follows:


A
B. typhosus + antityphoid immune body. + Complement.
Complement bound in A, not free to act on B.
B
Red cell + antired cell immune body.
(No hemolysis.)
A
B. typhosus + anticoli immune body. + Complement.
Complement not bound in A, and free to act on sensitized red cells.
B
Red cell + antired cell immune body.
(Hemolysis.)

As we have outlined the reaction it would appear that a positive (no hemolysis) result is wholly due to the fixation of complement by bactericidal antibodies. This is not the case. Other factors enter. We have already referred to the absorption of other antibodies by the precipitin-antigen complex. As Gay has shown, this complex will fix complement as well. Neisser and Sachs found that very minute amounts of human blood mixed with its antiserum would fix complement and suggested this method for forensic blood tests. Although the injection of blood serum may give rise to amboceptor as well as precipitins, most investigators believe the complement is bound by the precipitin-antigen complex. The complement may be bound even when no demonstrable precipitation occurs. For instance, in the presence of an excess of antigen the precipitate may not separate. The precipitin-antigen complex held in "solution" by the excess of antigen fixes complement. It is evident, therefore, that complement-fixation is a much more delicate antigen indicator, that is, the precipitin reaction.

Application of the Bordet-Gengou Phenomenon.—Three applications of this reaction should be apparent and theoretically possible: (1) The use of known antibodies to identify or classify unknown microorganisms; this application has been used to a considerable extent, but has many drawbacks as compared with the simpler agglutination reaction. When satisfactory agglutination antigens are not possible the reaction has considerable value. Closely allied types tend to give greater group reactions than are encountered with the agglutination reaction. These may be eliminated to some extent by careful titration of the reagents. (2) The second application is the demonstration of the presence and the identification of the antibodies in the patient's serum. This application is, therefore, a diagnostic procedure. This procedure is also employed in strengthening the evidence that a microorganism isolated from a disease is the causative agent. Naturally the

presence of antibodies does not prove that it is the primary etiological agent of the disease or infection, as the antibodies might develop if the organism were a secondary infecting agent. (3) The third application is the use of the reaction to quantitatively determine the content of complement-fixing antibodies in antibacterial serums to be used for therapeutic purposes.

OPSONINS AND PHAGOCYTOSIS.

Although it has been suggested by earlier observers that ingestion of bacteria by the body cells was a means by which the body destroyed bacteria, Metchnikoff was the first to experimentally prove this fact. This ingestion is followed by a digestion and is analogous to the feeding processes of unicellular organisms. Metchnikoff noticed that phagocytosis was more active in the presence of immune serum than with normal serum, but thought that this was due to the presence of leukocyte-stimulating substances in the serum. Denys and Leclef suggested that the action of immune serum might be upon the bacterium reducing their resistance of phagocytosis. By utilizing the technic of Leishman, Wright and Douglas definitely proved the existence of a substance in serum which, acting upon the bacterium, prepared it for phagocytosis. This substance Wright gave the name "opsonin."

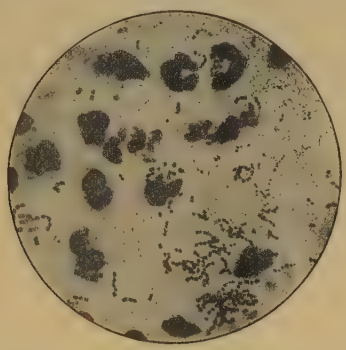


FIG. 9.—Streptococcus engulfed by leukocytes from abscess. Gentian-violet stain. × 1000. (Fränkel and Pfeiffer.)

The Phagocytic Cells.—Metchnikoff differentiated two varieties: the "motile or wandering" and the fixed phagocytes; the former, the leukocytes, the latter the endothelial cells, as well as certain fixed connective-tissue cells and cells of the lymphoid tissues (lymph-nodes and spleen) and of the neuroglia. The most active fixed phagocytes are the endothelial cells of the bloodvessels and serous cavities and lymph sinuses. The polymorphonuclear leukocytes he designated as "microphages," the large mononuclear leukocytes and the fixed phagocytes as "macrophages." The participation of these cells is seen in the process of inflammation. If an infection occurs, due to the streptococcus, there is an inflammatory response which is dominated by the

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collection of polynuclear leukocytes which are attracted ("positive chemotaxis") and pass through the wall of the capillaries to the tissues.

At the same time there is an accumulation of serous exudate. The polynuclear leukocytes as well as the local phagocytic cells attempt to dispose of the bacteria Fig. 9. If the infection progresses, the accumulation of cells continues and the leukocytes and tissue cells which are killed form the resulting "pus." This consists mostly of the accumulated leukocytes and serous elements.

If the infection had been due to tubercle bacilli a different type of inflammation would occur. The bacilli will be rapidly surrounded by large mononuclear cells, apparently endothelial in origin, and about the latter will develop an exudation of cells of the lymphocyte type. The polynuclear variety is not attracted ("negative chemotaxis"). Phagocytosis by the endothelioid cells and the giant cells formed from these is noticed. If the infection progresses, necrosis develops in the center of the cell mass, resulting in caseation. The polynuclear leukocytes, however, play a role in the preliminary attempt to dispose of the bacilli, as is seen in the phagocytosis when tubercle bacilli are introduced into a serous cavity.

In general infections the blood picture, total leukocyte and differential count, gives evidence of the positive or negative chemotactic character of the infecting organism. If an infection is due to an excessively virulent organism or if infection be extensive and severe a negative chemotaxis results even though the infecting agent is ordinarily of the positive variety.

Opsonins.—Opsonins are present in normal serum and in greater amounts in the serum of immune animals. Evidence has been advanced that the "normal" and the "immune" opsonins are not similar substances.

Thus the former are nearly destroyed by heating to 60° C. for fifteen minutes, whereas the latter seem more heat-resistant, not being markedly affected by heating to 62° to 63° for forty-five minutes. The question arises: What relationship, if any, have these substances to those already studied? Careful experiment, indicates that the opsonic action of normal serum is due to distinct antibodies. The action of normal opsonins is apparently due to a thermostabile (55° C.) substance present only in small amounts the activity of which is very much enhanced by other thermolabile (55° C.) substances, non-specific in character present in the serum. The latter substance is apparently the complement. The thermostabile substance is relatively specific in the sense that the absorption of normal serum by a specific organism will only remove those for itself or related organism, but not necessarily all the opsonic substances.

The immune opsonins or bacteriotropins (Newfeld) would resemble antibodies of the second order (Ehrlich) if the evidence advanced as to their heat resistance and inability to be reactivated by normal serum was conclusive. Dean, Hektoen and others, although admitting the

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thermostabile character of the immune opsonin, have shown that the action is enhanced by the addition of fresh normal serum, inactive in itself. It would seem, therefore, that there is no fundamental difference between the normal and immune opsonins or bacteriotropins. The apparent greater resistance of the latter may be partly because of their presence in greater concentration. In both instances the opsonic action is not completely lost on heating, thus apparently differing from the complete inactivation of bactericidal action brought about by the same means. This residuum may remain only apparently active, not being active in itself, but because the leukocytes used in the test supply traces of complement which reactivates the opsonic antibody. This hypothesis, however, rests on the still doubtful contention that the leukocytes are a source of complement. If this hypothesis were true it would explain the apparently greater heat resistance of immune opsonins, which, being in greater concentration, would require less complement to activate them. As we have pointed out, the greater the concentration of amboceptor the less complement is necessary. The fact that the opsonin value and the bactericidal action of a serum do not necessarily parallel each other quantitatively, indicates that the opsonic action is due to a distinct antibody and not due to the action of bactericidal amboceptor either alone or with complement. A final opinion, however, will be possible only when the doubtful points of opsonic action are settled.

Immune opsonins or bacteriotropins like other antibodies are specific for the stimulating microörganism. Some group action, however, may be evident, with closely related types. As with other antibodies, microorganisms exhibit a variable degree of resistance to the action of opsonins. This again is relatively proportionate to their virulence and source, and can be artificially modified. The resistance to phagocytosis may not be wholly due to resistance to the combination of opsinins. The bacterium may secrete substances which repel (see aggressins) or actually injure the leukocytes (leucocidins). As has been previously noted, capsule production is apparently a protection against antibody action. Pathogenic bacteria which have been cultivated on artificial media for some time may be spontaneously phagocyted, that is, phagocyted in the absence of serum.

Variations in Activity of Phagocytic Cells.—According to the fact given above, one would conclude that the increased phagocytic capacity of the cells of the immune host were wholly due to the increased opsonins. It has been shown that in lobar pneumonia the leukocytes may show an increased phagocytic power without regard to serum action. This may be due to other factors, as for instance, the age of the cell rather than to an acquired cell characteristic. Park and Biggs have shown that differences exist between the cells of apparently healthy individuals. Probably an equal degree of difference occurs with cells of the same individual at different times.

Mechanism of Phagocytosis.—The phenomenon of chemotaxis and of phagocytosis can be simulated with inanimate physical agents. A

study of these agents indicates that chemotactic action is due to substances which lower the surface tension of the cell. This causes attraction and results in phagocytosis, thus if the leukocyte meets a substance which reduces its surface tension it flows about or engulfs the substance. After ingestion, microörganisms are subjected to the action of the endolysins or ferments by which they are destroyed and digested.

Endolysins and Endo-enzymes.—Leukocytes, as shown by Schattenfroh, contain bactericidal substances. These can be extracted. They differ from similar serum antibodies in that they are more thermostabile, a temperature of 75° to 80° C. being necessary to destroy them. These substances have been termed "endolysins." Zinnser showed that one could extract no greater amount of these substances from the cells of immune than from normal individuals. Endolysins are not specific. Little if any of this substance is contained in the lymphocytes and macrophages. A number of enzymes have also been obtained from phagocytic cells, those of the leukocytes being called leukoprotease. Opie obtained two proteolytic ferments in the cells of exudates, one from the polynuclear cells, active in weak alkaline solutions, the other from exudates containing large numbers of mononuclear cells, active in weak acid solutions. The leukocytes possess no lipase which, however, is present in the macrophages. The leukocyte, therefore, cannot digest acid-fast bacilli such as the tubercle bacillus but carries them to the lymph nodes for digestion by the macrophage. In this way tubercle bacilli or other microörganisms, which resist the power of the leukocytic endolysins and endoferments may be disseminated by what is essentially a protective mechanism. Because of the presence of the above substances extracts of leukocytes may on injection have protective or therapeutic value.

Technic of Demonstration and Measurement of Opsonic Action.—Viable leukocytes may be obtained from sterile exudates or from the blood. In the former a 5 per cent. aleuronat suspension in a 3 per cent. starch solution in broth or a 25 per cent. solution of peptone is injected intraperitoneally into a guinea-pig or intrapleurally into a rabbit. After sixteen to twenty-four hours the animal is killed and the exudate is collected and added to about 20 c.c. of a 1 per cent. sodium citrate in an 0.8 per cent. salt solution. This is centrifuged, the leukocytes are again suspended in saline and are again sedimented, three or four times successively to wash away traces of serum. The leukocytes are then suspended in saline. Leukocytes are obtained from the blood by adding 1 part of blood to 15 to 20 parts of citrate salt solution, which prevents clotting. Small amounts, 1 c.c., may be obtained by deep puncture of the finger or the blood may be obtained from the vein by syringe. The blood of experimental animals may be used. The diluted blood is centrifuged at low speed. The red cells, having the greater specific gravity, are sedimented first, the leukocytes last, collecting as a creamy layer over the red cells.

The supernatant fluid is removed without disturbing this layer, and

leukocytes are collected with a capillary tube. They will be mixed with red cells. The leukocytes are now placed in saline in another centrifuge

FIG. 10.—Opsonic outfit. (Wright.)

tube, centrifuged and the cells washed free of serum as described above, and finally suspended in saline. The solutions employed should be

warmed to 37° C. as cold will affect the activity of the cells. Centrifuging at too high speed is to be avoided as this may clump the leukocytes. For careful work and especially if the activity of different cells is to be compared the cells in the suspensions should be counted and standardized to a definite content of polynuclear leukocytes.

The bacterial suspension may be either a saline suspension of the growth on agar or a broth culture. The culture selected must not give undue spontaneous phagocytosis nor should it be unduly resistant to opsonic action. The suspension must be of a satisfactory density.

The serum is collected from man by puncture, allowing the blood to flow into a Wright capsule (Fig. 10, *c*). The blood of experimental animals is collected from the vein and placed in a test-tube to clot. If necessary the clot is loosened from the glass so that it will contract and the serum separate.

The Method of Wright-Opsonic Index.—This method gives a comparison between the opsonic action of a serum with that from a normal individual or the pooled serum from several normals. The latter constitutes the control or standard measure. A capillary pipette is made and marked about an inch from the end. With a rubber teat the leukocyte suspension is sucked up to this mark, then a small bubble is allowed to enter the tip, then the bacterial suspension is sucked up to the mark, a bubble allowed to enter and last the serum drawn up to the mark. We now have three equal quantities of cells, bacteria and serum, separated by bubbles. The contents are then mixed by blowing out the contents on a slide and sucking it up, repeating this several times. Bubbling must be avoided. The contents, sucked well up into the tube, the tip is sealed in the flame, and the tube incubated at 37° C. for twenty minutes or longer Fig. 10, *d* and *e*. The tip is then nicked with a file and the contents again mixed, a drop placed on a slide, a smear prepared, using another slide, or cigarette paper as a spreader. This is then fixed and stained and examined with the oil-immersion lens. The leukocytes are more numerous along the edges of the smears. The average number of bacteria per leukocyte is determined by counting the contents of fifty or preferably one hundred cells. This is done with the normal or control serum and with the serum for test. The result is expressed by the opsonic index thus:

$$\frac{\text{5 per leukocyte-test serum.}}{\text{10 per leukocyte-control serum.}} = \text{Opsonic index, 0.5.}$$

Before carrying out this method the bacterial suspension must be standardized so that not more than five to ten bacteria per leukocyte will be taken up in the time of incubation. This is done by preliminary tests with the suspension and dilutions of the suspension.

Applications of the Opsonic Determinations.—Wright advocated the method as a means of control of vaccine therapy. Where vaccines are injected, Wright states, there "supervenes a negative phase where there is a diminished content in protective substances. This is succeeded by a positive phase. This inflowing wave of protective substances

rapidly flows out again, but leaves behind in the blood a more or less permanently increased content of protective substances. When a small dose of vaccine is given the negative phase may hardly appear but the positive phase may be correspondingly diminished. Where an unduly large dose of vaccine is inoculated the negative phase is prolonged and much attenuated. The positive phase may in such a case make default. It will be obvious that, if we, in the case of a patient who is already the subject of a bacterial invasion, produce by the injection of an excessive dose of vaccine a prolonged and well-marked negative phase, we may, instead of benefiting the patient, bring about conditions which will enable the bacteria to run riot in his system."

"Now consideration will show that we may obtain, according as we choose our time and our dose wisely or unwisely, either a cumulative effect in the direction of a positive phase or a cumulative effect in the direction of a negative phase. We may in other cases, by the agency

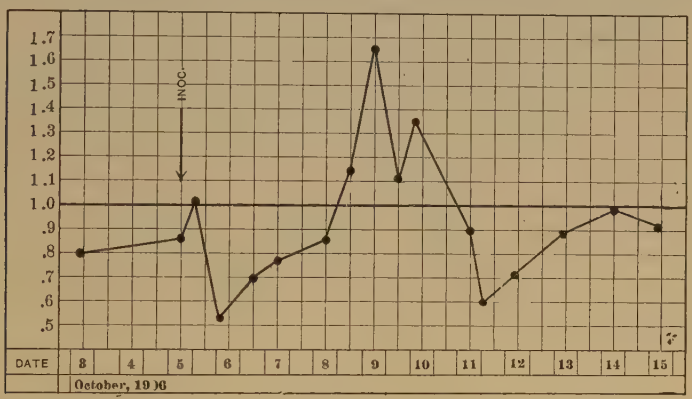

FIG. 11.—Opsonic curve, showing the slight immediate rise and the later negative and positive phases following inoculation. The changes here are more regular than generally occurs.

of two or more successive inoculations, raise the patient by successive steps to a higher level of immunity, or, as the case may be, bring down by successive steps to a lower level. We can select the appropriate time and dose with certainty only by examining the blood and measuring its content in protective substances in each case before reinoculating" (Fig. 11).

The reasons for the discontinuance of this method are several: (1) the relative inaccuracy of the method; (2) the fact that almost equal differences can be observed in normal or diseased individuals from day to day without regard to injections of vaccines; (3) injections were based, not on the index at the time of injection, but of the previous day because of the exigencies of the opsonic method; (4) the development of a negative phase is apparent, not real; (5) equally satisfactory results were obtained, controlling dosage by the degree of focal and systemic reaction.

The determination of the opsonic content of immune horse serum to be used for therapeutic purposes has been very generally employed, especially for the standardization of antimeningococcus serum. The method is far from satisfactory for the reasons given and is no longer employed as a routine test. The determination of the presence of an increased opsonic content has been utilized to a limited extent as a diagnostic procedure. On the whole the method is only applicable to special investigative work and the results must be scrupulously controlled and the results verified by many repetitions of the test.

Use of Antibacterial Serum for Therapeutic Purposes.—Sera having a high antibody content also show considerable protective value on animal injection. Likewise, therapeutic value is indicated for such sera in that they prevent or delay the death of experimental animals even when the serum is administered after the infecting dose of bacteria is given. The relative effect, however, is directly proportionate to the shortness of time which elapses between infecting and serum dose. This is partly due to limitations of such animal experimentation. These are imposed by the fact that we are not reproducing the natural disease in the animals but causing an infection, the only reliable criterion of the severity of which is the death or recovery of the animal. Because of these facts antibacterial sera have been utilized in man for both prophylactic and therapeutic purposes.

Titration of Sera.—*Standards.*—The methods employed and the standards adopted, vary to a great extent, as the problem involved is much more complex than with toxin-antitoxin methods. The methods possible of application are dilution titration of the antibodies, agglutinins, opsonins and bactericidal content and the determination of the protective value when injected with cultures. The agglutinin content is chiefly of value with typhoid and dysentery, although the content in these antibodies may decline after prolonged inoculation without, so far as we know, a coincident fall of other antibodies. The agglutination reaction is of some value in determining the probable antibody balance where several or many types of strains are employed as with dysentery and meningococci, this being the guide as to the pro-rata amounts to be injected into the horses. The value of this method is naturally influenced by the tendency of the horse to produce common agglutinins. Opsonic determination is only of comparative value. It cannot be used as a basis for a standard as it is open to serious error and variations beyond control. The bactericidal titration has found only limited application. The complement-fixation reaction has been of value in titrating meningococcus serum; and a rough standard that not more than 0.002 c.c. shall be required to give complete fixation, using a mixed antigen, is employed in several laboratories. The protective value of meningococcus serum, using white mice (Hitchens and Robinson[1]), promises to be of value. For pneumococcus serum protective experiments with white mice offers the best method. According to

[1] Jour. Immun., 1916, i, 345 and 355.

Cole, 0.2 c.c. of serum should protect against 0.1 c.c. (Type I) or 0.01 c.c. (Type II) of a broth culture (of which 0.000001 c.c. kills mice) when culture and serum are injected simultaneously. Protection experiments can also be applied to streptococcus serum, although difficulties may be encountered in raising the virulence of the strains.

On the whole the methods are far from satisfactory, titration of one antibody does not necessarily give us any information as to the content in other antibodies. Where many representative types are employed, the balance not only as regards one antibody, but possible variations in comparative content of different antibodies against the individual strains still further complicates matters, as well as insufficient knowledge of the actual immunological relationship of these strains. Protection tests are satisfactory where the bacterium is truly septicemic for the test animal, less so where invasion is less marked (meningococci) and of least value where death is due essentially to endotoxins. Protection tests, furthermore, only give us information concerning the strain used, and in the case of meningococci, for instance, we know little as to the degree of cross-protection with strains having agglutinative relationship. Furthermore, there is only partial knowledge as to the relation of the total antibody content to protection and finally to therapeutic effect in man.

Bleeding.—Bleeding for therapuetic sera are made with trocar and rubber tube into 2-liter Erlenmeyer flasks having a large flat wire egg-beater to support the clot. After the flask is about half-full, it is tilted on the side where the wire is inserted. The flasks may be stood up after the clot is firm. The serum separating after twenty-four and forty-eight hours is drawn off with siphon. All operations must be aseptic.

Serum.—The collected serum is placed in a sterile vessel and trikresol added, drop by drop, with vigorous stirring to prevent precipitation, until 0.4 per cent. is added. In two to three weeks, after which further fibrin separation usually ceases, it is passed through a Berkefeld filter to remove any contamination occurring at the time the trikresol was added. The trikresol will prevent any multiplication of the contaminants prior to filtration. Instead of trikresol one may add several cubic centimeters of chloroform per liter and shake, the excess settles out with any separated fibrin and is avoided when the serum is drawn up in the blotting apparatus. The sera must be kept in the refrigerator at all times and tested to determine its sterility before being issued.

Concentration.—This is not practised as it is with the antitoxins. To test the different fractions and determine which to use is, to a great extent, impracticable until we have better methods for standardization and a clearer knowledge as to what antibodies are essentially of therapeutic value.

Cross-protection and Strain Identity.—The error of assuming strain identity on the basis of insufficiently controlled protection tests is frequently heard. Thus, if antiserum A will protect against Strains A,

B, C, etc., this is advanced as proof of identity. As a matter of fact it is only an indication of group relationships. The following schematic presentation of the results of Avery will show this very clearly:

PNEUMOCOCCUS PROTECTION TESTS.

Variety of antiserum.	Variety of culture. Type II.	Subgroup IIa.	Subgroup IIb.
Type II	Protects	Protects	Protects
Subgroup IIa	No protection	Protects	No protection
Subgroup IIb	No protection	No protection	Protects

In other words the reverse phenomenon must be observed before conclusions are drawn. The question arises: would even mutual protection be complete evidence of identity? If this were encountered the relative degree of cross-protection which naturally should always be carefully controlled might reveal differences. Theoretically at least, there is no reason to believe that apparently complete mutual cross-protection might not occur with two closely related but not identical strains. If this is theoretically possible it again brings us to our previous theorem that *antibody absorption is our ultimate criterion.* This has been discussed primarily under agglutination, because agglutinin absorption is usually the expedient method since we can control the technic more easily and because quantitative estimations can be more easily and accurately made. The same principles, however, are applicable to the absorption of other antibodies.

HYPERSENSITIVENESS.

Enzymes and anti-Enzymes, Aggressins.[1]

In preceding pages we have considered the production of immunity through the introduction of antigenic substances. We have now to consider a phenomenon which seems at first to be the antithesis of immunity. Thus, if a very small amount of bacterial or other protein be injected into a guinea-pig, a change occurs so that while the first dose produces no noticeable reaction a second injection of the same protein given ten to fourteen days later will cause symptoms of shock or even death of the animal. This phenomenon Richet called "anaphylaxis." This reaction in the guinea-pig has been studied in detail with the hope that the evidence acquired would help explain somewhat similar phenomena encountered in infectious diseases as well as the reactions following the introduction of repeated injections of antitoxins or sera, ingestion of certain food or drugs (idiosyncrasies), etc. Furthermore, any reasonable hypothesis advanced in explanation of these phenomena would seem to apply to the development of the common symptoms (fever, etc.) of infections.

[1] For fuller discussion and bibliography see A. F. Coca: Hypersensitiveness, Tice's Practice of Medicine. V. C. Vaughan and W. J. Vaughan: Protein Split Products in Relation to Immunity and Disease.

The terminology as well as the classification of these altered reactions to foreign proteins is far from satisfactory on account of the many contradictory hypotheses advanced in explanation. It would seem wiser to limit the term anaphylaxis to the acute symptoms developing after an injection of protein, because of the sensitization induced by the previous injection or injections of the same protein, a phenomenon seen best in the experimentally induced condition in animals. One reason for this is that there is increasing evidence that this is a separate phenomenon. Another is that the use of the term for all the reactions seen in man following the administration of antitoxins and serums had led to undue fear of untoward reactions, as in the minds of most the term implies acute shock.

Anaphylaxis in Guinea-pigs.—Twenty-five years ago Theobald Smith, Park and others found that when an injection of horse serum was given to a guinea-pig which had been used for horse antitoxin testing some weeks before, striking symptoms developed and that fully half of the animals died in thirty minutes. Animals which had received no serum showed no reaction from the same dose. Rosenau and Anderson and Otto studied this phenomenon and showed conclusively that the antitoxic content of the serum was not a factor, but that the symptoms were wholly due to the serum proteins. It was found that an incubation period was necessary before the pig became hypersensitive and that as this period became longer the larger the initial or sensitizing dose. Very small amounts of serum sufficed to sensitize, even as little as 0.000001 c.c. Larger doses (approximately 1000 times the minimum sensitizing dose) are necessary to elicit symptoms. The size of dose depends on the rapidity of absorption. Thus a small dose will kill when given intravenously; a larger dose is needed if injected intraperitoneally and still more if given subcutaneously. The rapidity of development and the extent of symptoms developing after the second injection depend on the sensitiveness of the animal and the size and mode of administration of the dose. The guinea-pig first shows restlessness, then scratches at the mouth, coughs and develops spasmodic or rapid breathing. Urine and feces are discharged. The guinea-pig then falls on its side, breathing becomes difficult or arrested and spasmodic or convulsive movements supervene. The convulsions are usually followed by the death of the animal. Associated with these symptoms there are a fall in temperature, a leukopenia, a diminution in complement in the blood, and a delay or loss of blood coagulability. On autopsy the lungs are markedly distended, due to stimulation and contraction of the smooth muscle of the small alveoli, thus retaining the inspired air. This explains the respiratory symptoms noted before death. The heart continues to beat for some time after death. The contraction of smooth muscle is due to peripheral irritation.

In Rabbits.—It has been estimated that rabbits are $\frac{1}{400}$th as sensitive as guinea-pigs. Symptoms of anaphylaxis may be produced easily, but acute anaphylactic death occurs only irregularly. Several injections of serum are needed to sensitize the animal. Shock is most

constantly produced when 1 or 2 c.c. are injected at five-day intervals and then after three days giving daily intraperitoneal or intravenous injections of 0.2 c.c. for two weeks or more The shock injection 2 c.c. is given five days later by the intravenous route. The symptoms elicited are less marked than with the guinea-pig and the intense dyspnea is absent. Death is due to cardiac and vascular disturbance. The pulmonary arterial system is so contracted that perfusion of salt solution even under high pressure is impossible.

Besides acute anaphylaxis, Arthus has demonstrated a peculiar local effect following repeated doses of serum. If several or more injections of serum are given a rabbit, subsequent subcutaneous injections will frequently cause severe local reactions which may result in local necrosis (Arthus's phenomenon). This is not a cumulative effect, as previous subcutaneous injections caused no reaction even when given in the same place, whereas the later reaction occurs wherever there is an area of injection.

In Dogs.—Dogs may be sensitized with two injections of serum (first subcutaneous, second intravenous) five days apart. A shock dose of 20 to 30 c.c. given intravenously several weeks later will cause symptoms and death. Vomiting or retching and evacuation of the bowels are among the earliest symptoms. The circulatory disturbance is apparently due to engorgement of the liver resulting in a great accumulation of blood in this organ and in the portal vessels. This would account for the anemia and low pressure in the general circulation.

Dependence of Symptoms on Contraction of Smooth Muscle.—Schultz has demonstrated that the hypersensitiveness of smooth muscle is the main factor in anaphylactic response. In the guinea-pig this is shown by the contraction of the bronchial musculature. In rabbits and dogs this bronchial phenomenon is not marked, possibly because the bronchi are relatively poorly supplied with muscle, but the circulation disturbances in the dog and the rabbit are explainable on the same basis. The cause of the disturbance is the same, though there is a difference in the site of action. This effect on smooth muscle can be demonstrated on excised muscular organs such as the uterus.

Sensitization by Enteral Introduction.—In the preceding paragraphs sensitization by the parenteral administration has only been mentioned. Sensitization induced by feeding, has been reported by Rosenau and Anderson. Other observers have had contradictory results. It would seem that success depended on whether unchanged protein reached the large intestine, from which it can be absorbed.

Passive Anaphylaxis.—In contrast to the active sensitiveness, hypersensitiveness of one animal may be transferred to another by the injection of the blood or serum of the first animal. This is not only possible with animals of the same species (homologous, viz., guinea-pig to guinea-pig), but with animals of different species (heterologous, viz., rabbit to guinea-pig). Hypersensitiveness is transferred to the offspring of sensitized mothers; thus, young guinea-pigs may be sensitive for five or six weeks or longer after birth. Hypersensitiveness to specific toxin cannot

be passively transferred. There is no specific hypersensitiveness of the ordinary kind to exotoxins.

Unless the anaphylactogen (see below) and the immune serum are injected together anaphylactic symptoms cannot be induced in a guinea-pig by the injection of antigen, until some time (four to six hours) after the immune serum has been given.

In the rabbit and dog it may be induced immediately after injection of the immune serum.

The Anaphylactogen.—This term is applied to the substance which induces the state of anaphylaxis. All evidence indicates that only proteins which can act as antigens may become anaphylactogens. The proteins may be of animal or plant origin, including microörganisms and their extracts. Such proteins must be alien to the animal injected or at least alien to his circulation.

Probably the whole protein molecule is necessary to induce hypersensitiveness. Proteins split by digestion or chemical agents lose the sensitizing property. Heating diminishes or destroys the sensitizing action of proteins in proportion to the degree of coagulation caused by the heating. The ability to produce anaphylactic shock may be lost before the ability to sensitize, because minute residues of the original protein would still suffice for sensitization. Vaughan believes that the protein possesses a non-specific toxic portion and a specific sensitizing portion. He obtained two such fractions by treatment with an alcoholic solution of alkali. The sensitization by the one fraction could equally be used as an argument that all of the protein molecules had not been cleft. The anaphylactogen, at least with native proteins and bacteria, is specific, that is, only the same protein which was used for sensitization will cause anaphylactic symptoms. This specificity follows, as a rule, the biological origin, as has been noted with other antigens.

Similar Non-specific Phenomena.—The products of protein cleavage when injected intravenously in normal animals are toxic. An example has been noted, viz., that obtained by Vaughan. Peptone likewise causes the symptoms of anaphylaxis. Bordet showed that the addition of agar jelly to guinea-pig serum and subsequent incubation at 37° C. rendered the serum toxic. In fact, many substances, chloroform, colloidal silica, kaolin and even distilled water, will render normal or immune serums toxic. This toxicity manifests itself by causing anaphylactic symptoms. The same effect may be noted after intravenous injections of such substances, the toxification of the blood occurring *in vivo*.

Anti-anaphylaxis or Desensitization.—If animals survive the second dose of protein they are for some days relatively very insensitive to the protein. The injection into the guinea-pig of one or more small doses of the specific protein during the period of incubation has the same effect. This condition of desensitization is only temporary, sensitization again developing after several weeks. The serum of an anti-anaphylactic animal does not confer this property to a second animal; in fact the opposite occurs, the second animal becoming passively sensitized. The injection of an immune serum (specific for the protein) prior to the dose

of protein will interfere with development of anaphylactic symptoms. A relative resistance to anaphylaxis may also be induced by the injection of non-specific substances, proteins, peptones, etc., as well as with drugs, atropin, chloral, etc.

Theories of Anaphylaxis.—Two theories have been advanced which assume that the toxic agent is a digestion product. Vaughan believes that the first injection sensitizes the animal by stimulating the production of specific zymogen which when activated will cleave the protein on second injection, the products of this cleavage being toxic. The zymogen according to this conception would be an amboceptor-like antibody which would be activated by the complement. Friedberger maintains the same views based on his observations that the toxin, inducing anaphylactic shock, develops in test-tube mixtures of antigen and its antiserum; the term anaphylotoxins is used to designate the shock-inducing poison.

This conception then involves the idea that amboceptor and complement activity results in proteolytic cleavage. Jobling found no evidence that amboceptor and complement will cause proteolytic cleavage. Nor is there reason to believe that there is produced some other specific antisubstance having actual proteoclastic activity. To sustain his theory, Vaughan concludes that the anaphylotoxin and the poisons resulting from proteolytic cleavage are the same, because they cause the same physiological effect. By the same reasoning he would be forced to assume that the toxic product in a mixture of serum and a non-specific non-protein substance where no protein antigen is available for cleavage is again the same poison. Friedberger's idea that complement is essential to the reaction is also untenable for similar reasons.

Jobling in his earlier work met those objections by the hypothesis—that the digestion products come from the serum and not from the antigen. This digestion resulting from the depression or neutralization of the antitryptic substances which would allow the serum-protease to digest the serum. Non-specific substances as mentioned above would cause this effect because of their neutralizing action. Specificity could be assumed on this basis to be due to the fact that the antigen-antibody complex would possess this neutralizing action.

Both digestion theories fail in our opinion to explain the quick response especially of excised smooth muscle. Dale employing the reaction of the uterine muscle, has questioned whether toxic digestion products could be produced within the time between contact of antigen and muscle response. The rate of reaction is equal to that of a performed protein poison such as histamin. Digestion theories fail to interpret the delay in passive sensitization of guinea-pigs

Novy and De Kruif have elaborated a theory, drawing an analogy between the production of anaphylotoxin and the mechanism of blood coagulation. This latter results from the change of fibrinogen into fibrin through the so-called fibrin ferment. They assume the existence of a more or less labile matrix in the blood which is changed by a cata-

lyzer into anaphylotoxin. The two phenomena are similar, therefore, in that a labile substance undergoes rearrangement resulting in tautomeric modifications, on the one hand the insoluble fibrin, on the other, the soluble anaphylotoxin. This theory assumes that the non-specific substances noted above give rise to the same poison as is active in specific anaphylaxis. The only difference is that the antigen-antibody complex is the catalytic agent in specific anaphylaxis. This theory also fails to explain all the phenomena, especially the delay in passive sensitization. It does seem to eliminate the doubtful aspects of the digestion theories.

A moderate toxicity of the blood has been demonstrated by Novy for animals sensitized and shocked by relatively large doses of antigen or by non-specific agents. The question arises would this be so if the minimal shock-inducing dose had been used. Weil transfusing normal dogs with even the whole volume of dogs dying or dead of anaphylactic shock uniformly failed to demonstrate any increased toxicity. If the toxic products were formed in the circulating blood, one would expect to be able to demonstrate at least some toxicity.

If the digestion theories or that of Novy assumed the cell as the site of toxin production, the time factor raised by Dale would still be a difficulty.

All the theories thus far given do not take into consideration the fact that the organs of an immune animal are hypersensitive although the animal as a whole is not. This as well as the fact that the injection of immune serum specific for the protein to be used will prevent anaphylactic shock, indicates strongly that an excess of antibodies in the circulating blood acts as a protective barrier, preventing the antigen from reaching the cells.

Because of the facts given above, the opinion is gradually being adopted, that the site of the production of the toxic substances is in the cells. This is spoken of as the cellular theory. Many observers believe that the antigens combine with the cellular antibodies (sessile) and that the combination in some way injures the susceptible cells. Such a theory would be compatible with the delay in passive sensitization, the latent period being assumed necessary for cellular combination by the introduced antibody.

The question as to the antibody involved is not easily answered. The production of anaphylaxis in guinea-pigs in which complement is suppressed has been advanced as proof that complement is not involved in the reaction. The absence of demonstrable complement in the blood is not necessarily a demonstration of its absence in the cells. Most of the adherents of the cellular theory believe that the precipitins are involved in the reaction. This, at least, is not susceptible to direct proof. As we have seen, these antibodies are not easily produced in demonstrable amounts, and they are certainly not demonstrable in guinea-pigs sensitized with minute quantities of antigen. There is evidence, however, indicating that the capacity of serum to confer passive hypersensitiveness is proportionate to its precipitin content.

The fact that the washed specific precipitates resulting from antigen-antiserum mixtures will passively sensitize guinea-pigs does not necessarily indicate that the precipitin is involved. The precipitate, as we have seen, will carry down other antibodies as well. If a cellular theory as outlined is accepted, the specific anaphylotoxin must be assumed to be distinct from the toxin produced in the test-tube by admixtures of specific antigen and antiserum by serum and non-specific substances, as well as from the products of protein digestion. A theory that the first injection causes a physical change in the cells, rendering them hypersensitive to a second injection has been advanced.

On the whole, one cannot but conclude that no hypothesis thus far advanced is satisfactory. However, the value of these hypotheses as stimulants to experimental observation should not be underrated.

Anaphylaxis and the Symptoms of Infection.—Vaughan's theory of anaphylaxis has received such wide attention and acceptance because it seemed to explain in a satisfactory manner the toxic symptoms of infection caused by bacteria producing no demonstrable extracellular poisons. According to this conception the digestion products of the microbal protein would be the active agent. Carrying this conception further, the poison would be non-specific in character, being developed in the cleavage of any protein. Vaughan has shown that fever and the accompanying symptoms noted in all infections can be reproduced by the injection of protein cleavage products, the character of the fever depending on the size and number of doses injected. The hypothesis of Friedberger is very similar. The modified theories of anaphylotoxin production of Joblin or that of Novy could be similarly adapted as an explanation. Although there is strong doubt that digestive products play any role in the development of the anaphylactic reaction, the objections raised would not hold true in relation to the symptoms of disease. In the absence of more opposing evidence it seems probable that digestion products, although not due directly to antibody action may play a partial role at least in the production of disease symptoms. In this connection, however, it must be remembered that the mere autolysis in water of some microörganisms, for instance, the pneumococcus, will yield an acutely toxic substance. The question arises again, however, are such substances directly or indirectly poisonous. If, as seems implicated in such hypotheses, antibodies are necessary for the development of the poison it is difficult to understand the symptoms associated with very acute or fulminating infections.

Toxin Hypersensitiveness.—Because of certain phenomena, some investigators believe that there develops at times a hypersensitiveness to soluble or exotoxins, comparable to some extent with the hypersensitiveness to bacterial protein. It has been conclusively demonstrated that, if an M. L. D. dose of toxin is divided into ten or twenty parts and one part injected every day or every other day, death will take place when about 40 to 60 per cent. of the M. L. D. dose is given. It has also been observed that if several small doses of toxin are given, fifteen to twenty days later, additional doses of as little as $\frac{1}{100}$th M. L.

D. will cause death. Suggested explanations are that either certain cells stimulated by the previous injections have developed a greater avidity for the toxin or that some cells naturally possess a greater avidity. On either supposition these cells unite with a larger proportion of the toxin, when it is injected in small amounts.

Behring has made the statement that horses under immunization possessing large amounts of antitoxin in their blood, showed hypersensitiveness to the toxins. These animals, however, did not develop symptoms of tetanus or the specific changes due to diphtheria toxin, depending on which was being used in immunization. Doerr, Pick and others have pointed out that as we never inject toxin in a pure state, the symptoms were most probably due to the associated meat extractives peptone and products of bacterial autolysis present in the toxic broth. This is our opinion. We have immunized over 700 horses and have never encountered a reaction suggestive of toxin hypersensitiveness after antitoxin had developed. We have found that only those animals possessing no natural antitoxin will show such a phenomenon and they will no longer react in this way when antitoxin appears in the blood. This is true also for small animals.

We have already referred to the long delay which intervenes between the injection of toxin and the development of antitoxin in the guinea-pig or rabbit. This seems to have misled many observers, thus Loewis and Meyer reported that small animals which have no natural antitoxin will show no response to a single injection of a toxin-antitoxin mixture, but will respond with antitoxin development if a second dose is given some weeks later. Our own observations show that all animals will in time develop at least some antitoxin from a single dose. As has been pointed out, in the previous chapter, if antitoxin is normally present or if it has developed, a subsequent injection of toxin or of a toxin-antitoxin mixture will cause a quicker and greater response than in cases where no antitoxin is present. Hypersensitiveness of a different kind exists, therefore, in the sense that the ability of antitoxin production is increased.

Hypersensitiveness in Man.—Phenomena of hypersensitiveness in man may be observed after both the enteral and parenteral introduction of many and varied substances. These inducing substances may be divided into two groups, antigenic and non-antigenic, viz., those which stimulate and those that do not stimulate the production of demonstrable antibodies. The degree of response to such substances is largely personal idiosyncrasy and the symptoms, however diverse the agent, have a great deal of similarity. Coca has suggested the term allergy, introduced by von Pirquet, be limited to describe these individual peculiarities. A special term would certainly be advisable if it is eventually proved, as much of the evidence now indicates, that even where the inducing substance has antigenic properties, the reaction is not due to antigen-antibody combination or at least that the antigenic property has no bearing on the reaction.

Serum Reaction.—The untoward symptoms elicited in man by the introduction of serums with or without antitoxins may be divided into those following the initial injection and those following the second or later injections. These reactions have nothing to do with the antibody content of the injected serum.

Following the first injection three types of reactions may be noted: (*a*) collapse, with or without fatal outcome, (*b*) a symptom-complex called "serum sickness," (*c*) local necrosis. Each of these forms of response may follow the second or later injections.

Collapse or Death.—This rare accident has been noted nearly always after the first injection. The symptoms develop quickly after administration. In about 1 to 20,000 primary injections of antitoxin, alarming symptoms develop; in about 1 to 50,000 injections death results. The symptoms are those of extreme dyspnea and collapse. The dose may be small, in one instance about 1 c.c. (500 units) of antitoxin being given subcutaneously. Kerley reports a case of known hypersensitiveness where the dose was gradually increased until 4 minims were given, this resulted in alarming shock. The individuals showing this type of reaction are commonly those subject to "hay fever, or asthma," developing attacks especially in the neighborhood of horses. Nearly all of the children dying after serum shock are cases of "status lymphaticus."

A chill more or less severe is observed in about 40 per cent. of the cases after the intravenous injection of low-potency antitoxin, even when injections are given very slowly and the material warmed to the body temperature. In the Willard Parker Hospital the routine administration of antitoxin by the intravenous method has revealed that this probably depends on some special form of the protein, possibly upon a fine flocculent precipitate. With the best product less than 1 per cent. of intravenous injections produce a chill.

In some instances the intravenous administration of antitoxin or serum, several weeks or longer after an initial injection, which cause no marked reaction, has resulted in alarming symptoms of collapse. This effect almost never follows a second subcutaneous injection. In other instances, frequently repeated intravenous injection of serum has developed instead of a desensitization a hypersensitiveness so marked that even small amounts of serum woud give a sharp reaction. Such conditions are relatively very infrequent.

Serum Sickness.—The incidence of this type of reaction varies widely in different series of cases, from 10 to 60 per cent. or more. The size of dose will influence the percentage incidence. Because of the lower protein content and also because of the heating, the concentrated globulin preparations of antitoxin cause a relatively low incidence. Following the first injection of serum or antitoxin there is an incubation period varying from three hours to twenty-four days. More commonly the period ranges from three to twelve days. The symptoms are primarily a skin eruption, edema, slight albuminuria, variable both in incidence and in degree, enlargement of the lymph nodes with pain and tenderness, and pain in the joints. The eruption is very variable in character. A

local eruption appears earlier than the general eruption. On the second or later injections, the period of incubation may be absent or shortened "immediate or accelerated reaction," although this does not always occur. This condition is not serious, and in the many instances given no greater discomfort than any itching rash. Some samples of serum or antitoxin uniformly cause a skin eruption (scarlatinaform) earlier than others. The longer incubation periods are more frequently followed by urticarial rashes. It would seem from this that there were different reaction-inducing substances in serum or antitoxin.

Von Pirquet and Schick who have studied this condition in detail, believe that the reaction is due to antigen-antibody combination. They point out that the average incubation period coincides with the time of first appearance of precipitins in experimental animals. Likewise, they believe that the immediate or accelerated reactions following later injections are explained by the presence of developed or developing antibodies. This explanation, however, does not include the fairly common occurrence of a short incubation period. There is no parallelism between the presence of demonstrable precipitins in human beings and the appearance or severity of the reaction; in fact, precipitins may be present without allergy.

Local Reactions.—In very rare instances the primary injection of antitoxin leads to local necrosis. Although this occurs with extreme infrequency it should be a warning against injection under the breasts. When repeated injections are given, a final subcutaneous injection somewhat more frequently results in a sharp local reaction which may go on to necrosis. This may occur not only with serum, but also with rabies vaccine. The resemblance of this form of reaction to the Arthus phenomenon is marked. The necrosis is not due to bacterial contamination but the necrotic area may become infected and serious or fatal results ensue.

Desensitization to Serum.—Instances are noted with some frequency where first injections have caused reactions and following injections given several days or weeks later have produced little or none. This would seem to indicate a desensitization. As already noted, different batches of bactericidal or antitoxic serum will vary widely in their rash and temperature-producing qualities, and this may have been a factor in the development or non-development of symptoms. The administration of small doses of serum, prior to a first injection or prior to subsequent injections of those known to be sensitive, has not the regularity of desensitization noted in experimental animals. The observation of Kerley already noted is an example of such failure. Divided doses may fail to give a reaction or repeated small doses may apparently induce a tolerance, but this is no proof that we are inducing the mechanism of desensitization so uniformly producible in experimental animals.

Prevention of Serum Reactions.—Such individuals as give a strongly suspicious history may be tested cutaneously for evidences of hypersensitiveness. The appearance of a wheal indicates that the person will show a fairly immediate serum reaction, such as rise of temperature or

urticarial rash, but is no indication of the probable severity. The absence of a skin reaction indicates, but does not prove that there will be no reaction. The safest procedure, however, is to inject the serum or antitoxin in divided doses every twenty to thirty minutes starting with 0.1 c.c. and increasing the dose by 0.1 c.c. until symptoms are elicited or until sufficient is given. If symptoms develop one can attempt the repetition of smaller doses which had not caused symptoms. Where serum is to be administered intravenously, dilution and exceedingly slow administration at the beginning will help to avoid unfortunate results. Intraspinous injections should also be given slowly, especially the initial portion in those comparatively recently injected.

The introduction of serum intravenously or intraspinously in those with the evidence of the extreme forms of hypersensitiveness should not be undertaken unless urgently required.

Treatment of Developed Shock.—Hypodermic injection of epinephrin or atropin will usually relieve the less severe attacks. In extreme collapse artificial respiration may be tried.

Allergy to Foods, Pollens, etc.—Rashes and other forms of reaction are commonly exhibited by a small percentage of individuals after the ingestion of a specific food. This may follow eggs, certain meats, fish, fruits, etc. The inducing substances may or may not be antigenic in character. Hay fever is an example of mucous membrane hypersensitiveness. Such individuals may show skin sensitiveness or develop rashes or other symptoms when the inciting substance is injected. Such hypersensitiveness may be toward pollens, dust from hair or skin of animals. The experimental work with pollen extracts seems conclusively to demonstrate that the inducing substances are not antigenic in character, viz., they do not stimulate antibody production nor will they sensitize experimental animals. Hay fever (and probably food allergy) is not due to sensitization of the individual but to an inherited predisposition. The hypersensitiveness to a specific agent is not necessarily inherited.

The repeated use of small doses or high dilutions of substances involved in these reactions, will develop an increased tolerance. This is only relative and is not comparable to the regularly induced and quantitatively greater resistance of desensitized animals.

Similar hypersensitiveness is shown in varieties of dermatitis due to poison-ivy, sumac, etc.

Drug Allergy or Idiosyncrasy.—Although toxic in larger amounts, the allergic symptoms follow a dose or doses, which are not appreciably toxic for most individuals. The symptoms elicited are evidently due to idiosyncrasy as they are different from those obtained with larger and uniformly toxic doses. The agents involved are various, including mercury, salvarsan, iodids, quinin, morphin, antipyrin, salicylic acid, turpentine, sandalwood oil, etc. The common symptoms are fever with or without chill, skin eruption, local edema or gangrene at the site of injection, swelling of the joints and lymph nodes.

As has been noted most of the phenomena of allergy to serums, etc.,

have much in common in their symptomatology. We have no evidence that the basis of these reactions is an antigen-antibody reaction, a hypothesis, which seems to be required in specific anaphylaxis. The dominant fact in human allergy is rather that of idiosyncrasy. In only a small number of cases has a condition been noted resembling anaphylaxis, viz., local necrosis after repeated injections, and symptoms of collapse after a second injection. These may have been actual anaphylactic reactions. We have no reason to believe that anaphylaxis could not be induced in man as in other animal species. To elicit actual anaphylactic shock, however, the dose would have to be relatively large, even if man were as easily sensitized and shocked as is the guinea-pig, which is extremely unlikely. The usual dosage in man is much lower per body weight than necessary to cause shock in the guinea-pig. In the case of intravenous or intraspinous injections we cannot ignore, however, the factor of quick absorption.

Hypersensitiveness and Infection.—In many infections there develops in variable degree a hypersensitiveness to the substance or products of the infecting type. The most marked examples of this are noted in infections due to the tubercle and to the glanders bacillus. Tuberculin which consists of the soluble products found in a broth culture of the tubercle bacillus will serve as an example for discussion.

Tuberculin is only toxic for an infected animal, that is, infection results in hypersensitiveness. This hypersensitiveness is shown by the skin, the mucous membranes or by a systemic as well as by a focal reaction (site of lesion) when injected in sufficient doses. If the dose injected be sufficiently increased, death of the sensitive animal is caused. The substance or substances involved are highly resistant to heat, specific, but not anaphylactogenic. A relative tolerance can be induced in the tuberculous animal by gradually increased doses. The substance involved is different from all known anaphylactogenic substances and animals cannot be rendered hypersensitive by its injection. The proteins of the tubercle bacillus, however, are anaphylactogenic, but the hypersensitiveness to these, which can be induced in normal animals, is a distinctly different phenomenon. The mechanism of the tuberculin reaction is obscure.

A skin reaction is elicited in a considerable proportion of cases of syphilis by the intracutaneous injection of "luetin," an emulsion of the Treponema pallida. Similar indications of hypersensitiveness are noted in typhoid fever, or following the injection of typhoid vaccine by the ophthalmic or cutaneous method of introduction. Positive skin reactions have also been elicited by the gonococcus and also by some of the fungi. These reactions are relatively specific.

The Practical Value of the Skin Reactions.—Of those other than that of tuberculin is materially reduced because of the relatively frequent occurrence of non-specific skin hypersensitiveness, which leads to confusing reactions. The generally advanced explanation is that a specific immune body antigen complex is formed and this subjected to digestion by the local cells leads to the development of toxic products or to a

neutralization of the antiferment and digestion of the host's proteins. As the reaction develops relatively slowly, such explanations may be warranted. The reactions described, however, may not be due in some instances at least directly to the protein *per se*. Some secretion product which we cannot identify may be involved. With our present knowledge we are not justified in assuming an identity in the nature of these reactions and that of tuberculin, the active principle of which is dialyzable, and apparently non-protein in nature. There is reason to believe, however, that the tuberculin in itself does not cause the reaction. The site of infection is much more sensitive to its action than are other areas. It would seem as it something were elaborated in the lesion which was a contributing agent. Many believe this to be an antibody and explain focal and the local reactions are due to a tuberculin plus antibody complex. We have little if any direct evidence for this assumption.

Hypersensitiveness and Immunity.—Jenner observed the more rapid appearance of a reaction following vaccination after a previous vaccinia. This observation has been studied by others and the evidence indicates that such an accelerated response is an indication of immunity. In the case of tuberculin, the reaction is also indicative of immunity to reinfection. The disappearance of the reaction in a person with a latent lesion, during measles for instance, is not infrequently followed by extension of the lesion and tuberculous disease. Gay attempted to show that the appearance of a positive skin reaction to typhoidin was an indication of immunity to typhoid fever. This at least is not absolute, as the reaction is absent or disappears at a time after infection or vaccination when immunity is known to still exist.

Because of the immunity-index character of the tuberculin reaction and the accelerated reactions observed in vaccinia, the conception that active immunity is basically a sensitization of the body cells has been advanced. This sensitization of the cells it is believed, is due to an acquired temporally and quantitatively exaggerated ability of response, the acquisition of this capacity being due to the stimulus of the immunizing agent. The basis of this ability we may conceive as due to the persistence of cellular antibodies (sessile). Stimulation may result also in the release of the antibodies as well as a rapid reproduction. In the case of antitoxic immunity this is actually demonstrable. In the case of the antimicrobal type of immunity the results of injections of vaccines in immune individuals indicates that the antibody response is greater in immune than in the normal individual. The results of some observers have shown striking differences. Other observers have obtained very much less marked results. Non-specific factors are involved to some extent in this difference. The injection of a non-specific vaccine according to Jobling will cause a dispersion or release of preformed antibodies, thus increasing the blood content. Gay attempted to show that immune typhoid rabbits responded with a specific leukocytosis, that is, a specific cell-production stimulation resulted when injected intravenously with typhoid vaccine. McWilliams was unable to verify these results.

ENZYMES AND ANTI-ENZYMES.

Microbal Enzymes.—Pathogenic bacteria have enzymes which are necessary to their nutrition. When grown in media we find evidence of their action in proteolytic or carbohydrate cleavage or both. The degree of influence of such products in infection is not known. Certain bacteria secrete enzymes which are capable of digesting other bacteria such as pyocyanase secreted by the B. pyocyaneus. This product has been utilized for therapeutic purposes especially in localized infections.

Enzymes (Ferments) of the Host.—Man and other animals possess digestive ferments not only in the intestinal canal but also in the body cells and fluids. As we have no evidence that proteins, microbal or other, are split by antibody-complement action we must look to these non-specific enzymes as the means by which the body disposes of parenterally introduced proteins. At least we are forced to this assumption unless we can demonstrate the development of specific enzymes for the introduced material. The apparent demonstration of this by Abderhalden is rendered very doubtful by the contradictory evidence of other observers. In some instances, the observations as to specificity of reaction seem conclusive, but this specificity may be due primarily to specific antibody action, the digestion being a secondary non-specific phenomenon. As we have seen under anaphylaxis the source of the digestion products may not come from the foreign protein but from the proteins of the host.

Antienzymes (Antiferments) of the Host.—These substances can be demonstrated in the blood serum and are apparently the means by which autodigestion is prevented. According to Jobling and Peterson the antitryptic action of blood serum is due to the lipoids. Under anaphylaxis we considered the hypothesis that these substances may have a direct bearing not only on the phenomenon of anaphylaxis but also on the development of disease symptoms. If Jobling's hypothesis be accepted the bacterial products alone or combined with their specific antibody will neutralize the antienzyme leading to the development of "serotoxin" by the action of the serum protease.

There is another phase which seems equally important. Bacteria seem to resist ferment action because of their lipoid content. Their limiting membrane is supposed to be lipoidal in character. This resistance is enhanced when bacteria are treated with lipoids. This would seem to explain both the resistance of the tubercle bacillus to digestion as well as the peculiar caseation of tuberculous lesions. The large amount of lipoids in the bacilli serves to inhibit the ferments liberated by disintegration of the tissue cells. The balance of enzyme and antienzyme is apparently a factor in the effects obtained in non-specific protein therapy (see under Vaccines).

Aggressins—Virulins.—Welch has offered the hypothesis that bacteria, like the cells of the host, react, with the production of protective antibodies which limit or prevent the action of the host's curative mechan-

ism. Such adaptions would then underlie the characteristics of pathogenicity and virulence and explain the phenomena of bacterial resistance already described.

Antiblastic Immunity.—This term was introduced by Ascoli to define the inhibitive action of immune serum on the metabolic processes of bacteria. Because of his failure to demonstrate a bactericidal or opsonic action *in vitro*, he believed that the activity of antianthrax serum resided in its antiblastic capacity, evidenced in one way by inhibition of capsule formation. Prior to his observation von Dungern and others observed similar inhibitive phenomena with immune sera, viz., restraint of pigment production by B. pyocyaneus, of proteolytic emzyme action by staphylococcus. In the latter case immune serum neutralized the enzymes obtained from the cocci, indicating that an antienzyme antibody was involved. Dochez and Avery have more recently studied this phenomenon with antipneumococcus serum. Although antipneumococcus serum fails to cause bacteriolysis, it will inhibit multiplication for a certain period of time. This without further analysis is apparently due directly to antienzyme action or interference with the utilization of carbohydrates and nitrogenous compounds. A closer analysis (Blake[1]) indicates that the effect is due to agglutination, thus preventing the diffusion of the cocci throughout the medium and therefore diminishing the degree of utilization of foodstuffs. It is questionable how far the inhibition of special functions interferes with the infectious power of bacteria, especially when it is demonstrable that multiplication takes place in spite of such suppression.

[1] Jour. Exper. Med., 1917, xxvi, 563.

CHAPTER III.

PREVENTION OF INDIVIDUAL INFECTIOUS DISEASES.

By WILLIAM H. PARK, M.D.

INFLUENZA AND THE CONTROL OF EPIDEMICS DUE TO INFECTIONS INTRODUCED THROUGH THE RESPIRATORY MUCOUS MEMBRANES.

Influenza is an infectious disease characterized by great prostration and often inflammation of the mucous membranes, particularly of the respiratory tract. It is very doubtful whether what we call influenza is really an entity.

Influenza prevails without regard to climate. It occurs sporadically, in epidemics and in great pandemics. The sudden eruption of epidemics in localities from which the disease has been long absent, and where there has been no known new importation of infection, may be explained by assuming that the infectious agent, whether some special virus or merely some one of the microörganisms causing inflammation of the mucous membranes, has been brought in by a carrrier from outside or has remained attenuated in the respiratory or conjunctival secretions for years, and then becomes through some change in conditions virulent again when under favorable circumstances it may communicate infection to others and gain a further virulence which starts a continental or world-wide infection. A committee of the American Public Health Association of which I was a member brought together in a brief form the results of the experience derived from the last pandemic. The more important portions are given below in full. This report is not only of interest with respect to handling an influenza epidemic, but it considers measures applicable to controlling all infections of the respiratory tract.

The present epidemic is the result of a disease of extreme communicability. So far as information available to the committee shows, the disease is limited to human beings.

The microörganism or virus primarily responsible for this disease has not yet been identified. There is, however, no reason whatsoever for doubting that such an agency is responsible for it.

While the prevailing disease is generally known as influenza, and while it will be so referred to in this statement it has not yet been satisfactorily established that it is the identical disease heretofore known by that name, nor has it been definitely established that all preceding outbreaks of disease styled at the time "influenza" have been outbreaks of one and the same malady.

There is no known laboratory method by which an attack of influ-

enza can be differentiated from an ordinary cold or bronchitis or other inflammation of the mucous membranes of the nose, pharynx, or throat.

There is no known laboratory method by which it can be determined when a person who has suffered from influenza ceases to be capable of transmitting the disease to others.

Deaths resulting from influenza are commonly due to pneumonias resulting from an invasion of the lungs by one or more forms of streptococci, or by one or more forms of pneumococci, or by the so-called influenza bacillus, or bacillus of Pfeiffer. This invasion is apparently secondary to the initial attack.

Evidence seems conclusive that the infective microörganism or virus of influenza is given off from the nose and mouth of infected persons. It seems equally conclusive that it is taken in through the mouth or nose of the person who contracts the disease, and in no other way, except as a bare possibility through the eyes, by way of the conjunctivæ or tear ducts.

Prevention.—If it be admitted that influenza is spread solely through discharges from the noses and throats of infected persons finding their way into the noses and throats of other persons susceptible to the disease, then no matter what the causative organism or virus may ultimately be determined to be, preventive action logically follows the principles named below and, therefore, it is not necessary to wait for the discovery of the specific microörganism or virus before taking such action.

I. Break the channels of communication by which the infective agent passes from one person to another.

II. Render persons exposed to infection more resistant, by the use of vaccines.

III. Increase the natural resistance of persons exposed to the disease, by augmented healthfulness.

I. Breaking the Channels of Communication.—(*a*) By preventing droplet infection. The evidence offered indicates that this is of prime importance.

(*b*) By sputum control. The evidence offered indicates that the danger here is due chiefly to contamination of the hands and common eating and drinking utensils.

(*c*) By supervision of food and drink. Evidence offered does not indicate much danger of infection through these channels.

Details and practical methods possible for the limitation of infection through droplets, sputum, and food and drink are discussed later under special preventive methods.

II. Immunization and Vaccines.—(See also the report on bacteriology on page 84.)

In the present epidemic vaccines have been used to accomplish:

1. The prevention or mitigation of influenza *per se.*

2. The prevention or mitigation of complications recognized as due to the influenza bacillus or to various strains of streptococci and pneumococci.

In relation to the use of vaccine for the prevention of influenza, the evidence which has come to the attention of the committee as to the success or lack of success of the practice is contradictory and irreconcilable. In view of the fact that the causative organism is unknown, there is no scientific basis for the use of any particular vaccine against the primary disease. If used, any vaccine must be employed on the chance that it bears a relation to the unknown organism causing the disease.

The use of vaccines for the complicating infections rests on more logical grounds, and yet the committee has not sufficient evidence to indicate that they can be used with any confident assurance of success. In the use of these vaccines the patient should realize that the practice is still in a developmental stage.

The committee believes that when vaccines are used experimentally for the purpose of determining their preventive or curative value, the following conditions should be complied with:

1. The groups of vaccinated and unvaccinated persons should be sufficiently large and the actual number of persons in each group should be accurately known.

2. The relative susceptibilities of the two groups should be equal, as measured by age and sex distribution, previous exposures to infection without development of influenza and a previous history as to recent attacks of the disease.

3. The degree of exposure in each group should be practically the same in duration and intensity.

4. The groups should be exposed concurrently during the same stage of the epidemic curve.

III. Increased Natural Resistance of Persons Exposed to Infection.—Physical and nervous exhaustion should be avoided by paying due regard to rest, exercise, physical and mental labor and hours of sleep. The evidence is conclusive, however, that youth and bodily vigor do not guarantee immunity to the disease.

The nature of the preventive measures practicable and necessary in any given community depends in a large part upon the nature of the community itself, as to population characteristics, industries, and so on, and upon the stage and type of the epidemic curve. For example, the measures to be adopted in a purely rural community would not be practicable or desirable in a large metropolitan area, nor would the measures desirable and feasible at the beginning or end of an epidemic be found those best adapted for the intervening period. The committee has found it impossible, therefore, to lay down any rules for the guidance of all health officials alike in preventive measures. The most it has been able to do has been to state certain general principles that in its judgment should underlie administrative measures for the prevention of influenza. The application of these principles to the needs of any particular community must be left for determination by the officers of that community who are responsible for the protection of its public health.

The preventive measures recommended by the committee are as follows:

A. Efficient organization to meet the emergency, providing for a centralized coördination and control of all resources.

B. Machinery for ascertaining all facts regarding the epidemic:

1. Compulsory reporting.

2. A lay or professional canvass for cases, etc.

C. Widespread publicity and education with respect to respiratory hygiene, covering such facts as the dangers from coughing, sneezing, spitting, and the careless disposal of nasal discharges; the advisability of keeping the fingers and foreign bodies out of the mouth and nose; the necessity of handwashing before eating; the dangers from exchanging handkerchiefs; and the advantages of fresh air and general hygiene. Warnings should be given regarding the danger of the common cold, and possibly colds should be made reportable so as to permit the sending of follow-up literature to persons suffering from them. The public should be made acquainted with the danger of possible carriers among both the sick and the well and the resultant necessity for the exercise of unusual care on the part of everybody with respect to the dangers of mouth and nasal discharges.

D. *Administrative Procedures:*—1. There should be laws against the use of common cups, and improperly washed glasses at soda fountains and other public drinking places, which laws should be enforced.

2. There should be proper ventilation laws, which laws should be enforced.

Since the disease is probably largely a group or crowd problem, the three following sub-heads are especially important.

3. *Closing:*—Since the spread of influenza is recognized as due to the transmission of mouth and nasal discharges from persons infected with influenza, some of whom may be aware of their condition but others unaware of it, to the mouths and noses of other persons, gatherings of all kinds must be looked upon as potential agencies for the transmission of the disease. The limitation of gatherings with respect to size and frequency, and the regulation of the conditions under which they may be held must be regarded, therefore, as an essential administrative procedure.

Non-essential gatherings should be prohibited. Necessary gatherings should be held under such conditions as will insure the greatest possible amount of floor space to each individual present, and a maximum of fresh air, and precautions should be taken to prevent unguarded sneezing, coughing, cheering, etc.

Where the necessary activities of the population, such as the performance of daily work and earning of a living, compel considerable crowding and contact, but little is gained by closing certain types of meeting places. If, on the other hand, the community can function without much of contact between individual members thereof, relatively much is gained by closing or preventing assemblages.

Schools.—As to the closing of schools there are many questions to be considered.

(*a*) Theoretically, schools increase the number and degree of contacts between children. If the schools are closed, many of the contacts which the children will make are likely to be out of doors. Whether or not closing will decrease or increase contacts must be determined locally. Obviously, rural and urban conditions differ radically in this regard.

(*b*) Are the children in coming to and going from school exposed to inclement weather or long rides in overcrowded cars?

(*c*) Is there an adequate nursing and inspection system in the school?

(*d*) Is it likely that teachers, physicians and nurses can really identify and segregate the infected school child before it has an opportunity to make a number of contacts in halls, yards, rooms, etc.? We suggest that children suspected of having influenza and held in school buildings for inspection should be provided with and required to wear face masks.

(*e*) Will the closing of schools release personnel or facilities to aid in fighting the epidemic?

(*f*) If schools are kept open, will the absence of many teachers lower the educational standards?

(*g*) If a number of pupils stay at home because of illness or fear, will they not constitute a heavy drag upon their classes when they return?

(*h*) If schools are closed, is there likely to be an outbreak in any case when they are reopened?

Churches.—If churches are to remain open, services should be reduced to the lowest number consistent with the adequate discharge of necessary religious offices, and such services as are held should be conducted in such a way as to reduce to a minimum, intimacy and frequency of personal contact.

Theaters.—As regards theaters, movies, and meetings for amusement in general, it seems unwise to rely solely or in great part upon the ejection of careless coughers. In the first place it is difficult to determine who is a careless cougher, and after each cough, danger has already resulted. It seems, too, that the closing of theaters may have as much educational value as their use for direct educational purposes, etc. Discrimination as to closing among theaters, movies, etc., on the basis of efficiency of ventilation and general sanitation, may be feasible.

Saloons, etc.—The closing of saloons and other drinking places should be decided upon the basis of the probability of spread of the disease through drinking utensils and the conditions of crowding.

Dance Halls, etc.—The closing of dance halls, bowling rooms, billiard parlors and slot-machine parlors, etc., should be made effective in all cases where their operation causes considerable personal contact and crowding.

Street Cars, etc.—Ventilation and cleanliness should be insisted upon in all transportation facilities. Overcrowding should be discouraged. A staggering of opening and closing hours in stores and factories to

prevent overcrowding of transportation facilities may be cautiously experimented with. In small communities where it is feasible for persons to walk to their work it is better to discontinue the service of local transportation facilities.

Funerals.—Public funerals and accessory funeral functions should be prohibited, being unnecessary assemblies in limited quarters, increasing contacts and possible sources of infection.

4. *Masks.*—The wearing of proper masks in a proper manner should be made compulsory in hospitals and for all who are directly exposed to infection. It should be made compulsory for barbers, dentists, etc. The evidence before the committee as to beneficial results consequent upon the enforced wearing of masks by the entire population at all times was contradictory, and it has not encouraged the committee to suggest the general adoption of the practice. Persons who desire to wear masks, however, in their own interests, should be instructed as to how to make and wear proper masks, and encouraged to do so.

5. *Isolation.*—The isolation of patients suffering from influenza should be practiced. In cases of unreasonable carelessness, it should be legally enforced most rigidly.

6. *Placarding.*—In cases of unreasonable carelessness and disregard of the public interests placarding should be enforced.

7. *Hospitalization.*—The theory of complete hospitalization is that, if all the sick were hospitalized the disease would be controlled. In certain somewhat small communities where hospitalization of all cases was promptly inaugurated the disease did come quickly under control. It must be recognized, however, that unless every infective person can be detected and identified as such and removed to the hospital before he has infected others, hospitalization cannot be depended upon to eliminate the disease.

In general, home treatment is to be advocated where medical, nursing and other necessary facilities are adequate, and where home treatment is not directly contra-indicated by the danger of infecting others. The hospitalization in any case, mild or severe, should be undertaken only when facilities for home treatment are inadequate with respect to medical and nursing care or otherwise. The objection to routine hospitalization of mild cases lies in the fact that patients not already suffering from secondary infections may acquire them by exposure to hospital cases already so infected. The objection to the routine hospitalization of severe cases lies in the danger to the patient necessarily incident in the transfer from home to the hospital.

8. *Coughing and Sneezing.*—Laws regulating coughing and sneezing seem to be desirable for educational and practical results.

9. *Terminal Disinfection.*—Terminal disinfection for influenza has no advantage over cleaning, sunning and airing.

10. *Alcohol.*—The use of alcohol serves no preventive purpose.

11. *Sprays and Gargles.*—Sprays and gargles do not adequately protect the nose and throat from infection, for the following reasons:

(*a*) So far as the knowledge of the committee extends, no germicide strong enough to destroy infective organisms can be applied to the nose and throat without at the same time injuring the mucous membranes.

(*b*) Irrigation of the nose and throat to accomplish the complete mechanical removal of the infective organism is impracticable.

(*d*) Their domestic use is liable to lead in families to a common employment of the same utensils.

(*e*) The futility of sprays and gargles has been demonstrated with respect to certain known organisms such as the diphtheria bacillus and the meningococcus.

Miscellaneous Considerations.—1. Colleges, asylums and similar establishments may with advantage enforce rigid institutional quarantine against the outside world, if they begin in the early stage of an epidemic, provided they are so located and conducted as to render the procedure reasonably likely to be effective, even temporarily; for even temporary success will postpone the appearance of the disease, if it appears at all, to a time when the patients will be more likely to be able to have adequate medical and nursing care.

2. The recommended measures for control, even if they do not accomplish the desired end, should at least be instrumental in distributing the epidemic over a longer period of time, which in itself is highly desirable.

3. The statistics of the disease and the keeping of proper records are extremely important. The lack of knowledge regarding innumerable factors in reference to the disease makes all the more desirable complete case records, etc.

4. The committee wishes to emphasize the need for the complete statistical study of the collected data on the mortality, morbidity, case fatality, duration, economic aspects, and therapeutics of the disease. Through the collection of the facts in a uniform manner, and through the analysis of such tabulated data, especially mathematical graduation and testing and study of the figures, important contributions to the natural history and typical characters of the disease may be expected. General principles as to the etiology, fatality and practical management of influenza may follow from the extensive survey of the epidemic in the statistical laboratory as well as from the intensive bedside observation of single cases of the disease.

5. The measures recommended are calculated to be effective in the promotion of respiratory hygiene in general and particularly in the control of pneumonia and other respiratory infections.

Administrative Measures for Relief.—The committee on administrative measures for relief would submit the following considerations as constituting a summary of the important measures for meeting epidemic conditions:

I. General Rules.—1. Compulsory reporting.

2. Isolation, by coöperation and education, to a point where it does not diminish the willingness of the physician to report.

3. Placarding would seem to be subject to the same limitations as is isolation.

4. The closing of many agencies will release medical, nursing, and volunteer services for special influenza work.

5. It may be necessary to grant authority and power to the health authorities to administer relief.

II. Preliminary Measures.—1. The listing and distribution of resources, including physicians, nurses, social workers, nurses' aids, clerks, domestics, laundresses, automobiles, chauffeurs, mask makers and volunteers of all kinds.

All available publicity channels should be used to promote volunteer service.

An appeal should be made for voluntary donors of human blood serum from convalescent influenza patients, to be held in readiness for use in treatment.

2. The centralization of resources, under one control, with central and branch headquarters, the city being districted for medical, nursing and other work.

The central headquarters should be ordinarily under the supervision of a board representative of the most important agencies concerned, the board's work to be administered through a manager (presumably the health officer) selected for his fitness.

3. The service should be maintained on a twenty-four-hour basis, and a system of outgoing and incoming telephone service is essential.

4. The local authorities should get and keep in touch with State and national agencies.

III. Current and Continuous Analysis of Case Situation.—1. In the smaller communities a canvass should be made of all physicians, soliciting information as follows:

(*a*) Number of cases under care.

(*b*) Number of cases needing hospital treatment.

(*c*) Number of cases needing home nursing care.

(*d*) Number of cases requesting medical service but not reached.

This information will indicate the situation as regarding the need for emergency nursing and medical service, and should be acquired as fully as possible in larger communities, through various agencies such as a current lay or police canvass of homes, etc. The continuous classification of cases according to these groupings is of practical value.

IV. Analysis, Augmentation and Organization of Principal Facilities.—(*A*) *Field Nursing.*—1. Ordinarily nursing facilities utilized in general public health work should be diverted to meet the epidemic situation, and should be used on a district basis, with all other available facilities, under one supervision.

2. Nursing assistants, volunteers, etc., should be used wherever possible in homes and institutions, under expert supervision, after classification and assignment on a basis of minimum standards as to fitness, and such intensive training in the care of influenza and pneumonia patients as may be feasible.

3. From the standpoint of the patient, home treatment is to be advocated, if medical, nursing, disease preventive and other facilities are adequate.

4. Restriction so far as possible through the pressure of public opinion should be brought against the unnecessary use of private nurses.

5. Automobile transportation should be provided, and the nursing service used to encourage isolation and education.

6. Special record forms are essential for this and the medical work, and a special subcommittee is prepared to meet this problem.

7. Provision as to housing and care should be made for out of town nurses

8. We recommend further training with reference to influenza for. all graduates of Red Cross home nursing courses and more extensive use of their services. This would necessitate frequent and careful registration (names, addresses and telephone numbers) and further information regarding personal health, age and ability and willingness to serve.

(*B*) *Emergency Medical Service.*—1. The medical service should be handled through the central office, the physicians being responsible to the central office, though perhaps assigned to district offices.

2. In this emergency service there should be utilized all available physicians such as school and factory physicians, volunteers, practitioners on a paid basis, fourth-year medical students, etc. This service should cover all calls reported, as unreached by private physicians or received through other channels and should be coördinated with the special nursing service, being provided with automobile transportation, machines being hired if necessary.

3. The emergency medical service should be used to select cases needing hospital care.

4. It may be feasible to institute a central clearing house in certain districts for private physicians' calls.

5. An arrangement should be made through the medical licensing board for the granting of temporary permits to practice to reputable physicians from out of the State, at the request of the Central Influenza Committee.

6. In some localities it may be feasible to district the local practitioner and to have him meet special calls on a part-time basis for adequate compensation.

7. Certain of the relatively non-essential specialties should be discouraged, and the physicians in those specialties urged to volunteer for emergency district work. This type of service may be operated on a pay or free basis.

8. Presumably some effort should be made, through an authoritative medical commission, to suggest standard methods of treatment, and wise limitations as to therapeutic procedure.

(*C*) *Hospital Facilities.*—1. It is essential that the facilities, if possible, be kept ahead of the demand. A daily canvass should be made and data collected regarding available beds, medical and nursing

needs, domestics, food, cots, supplies, etc. A regular visit by an inspector will probably prove more effective than an attempt at telephone communication.

2. Under most conditions a central clearing house, covering most if not all of the hospitals, is advisable for the admission of cases. Through this channel the severer cases may receive first consideration. Owing to constant changes in the hospital bed situation, the daily canvass of facilities may not be wholly depended upon; on the contrary, it may usually be necessary to telephone the hospital in order to make sure regarding the admission of a particular case. In any event the hospitals, if facilities are inadequate, should be impressed with the necessity for admitting only the most severe or needy cases, pay or free. Special hospital arrangements should be provided for pregnant women.

3. It is advisable to add wards or tents or new equipment to existing institutions rather than to establish entirely new emergency hospitals. If practicable, certain hospitals may be urged to handle influenza cases exclusively.

4. Non-emergency surgical and chronic medical cases amenable to home treatment should be dehospitalized.

5. A convalescent home, if adjacent to the hospital, may serve for the care of mild and convalescent cases, thereby increasing the space in the hospital for acute cases, obviously involving an increase in the nursing facilities.

6. A canvass of ambulance facilities should be made, ambulances being requisitioned with payment, or hired by contract, if necessary. Automobiles and motor trucks should be potentially mobilized for this purpose. Frequently military equipment may be used if accessible.

V. Social and Relief Measures.—1. The central office should keep the family advised regarding the patient, thereby saving telephone calls, trolley fares and worry on the part of the family, and thereby increasing the willingness for hospitalization.

2. Volunteer workers such as Red Cross volunteers, teachers, relatives, etc., should be placed in care of families where the responsible members are dead or hospitalized, this service being under expert social supervision, and the families in touch with the supply system. Supervision of placed-out children is also necessary.

3. Homes should be investigated before patients are discharged into them, when destitution or other untoward circumstances are apparent.

4. Precaution should be taken that institutions and families too busy with the influenza situation to look after their own needs, are covered by the general relief measures.

5. Ordinary charitable relief should be handled through the routine agencies, the service coördinated with the other epidemiological measures. Churches, lodges, etc., should be urged to handle their own cases, in order to relieve the pressure on the central agency. Aid should be immediate, without protracted investigation.

6. Recreation facilities (motoring, etc.) should be provided for the physicians and nurses while off duty.

VI. Food.—1. Available central cooking facilities should be used so far as is necessary, such as the dietetic equipment in high schools, normal schools, colleges, etc., with a delivery system to families and institutions in need.

2. Individual families should be encouraged to cook additional amounts, the same to be delivered to central diet kitchens for distribution, a standard list of prepared foods needed being devised and advertised, with recognition of racial customs and preferences.

3. It may be necessary to establish canteens in sections of the city.

VII. Laundry.—1. A special collection and distribution system may be essential both for homes and institutions.

2. It may be necessary to take over a public laundry with compensation, or a private non-medical institution laundry.

VIII. Provision for Fatalities.—1. Death reporting should be prompt (twenty-four hours) and a record kept so as to insure prompt disposal of bodies.

The number of graves required should be estimated and labor released from public works or secured through other channels (possibly military) for digging. Possibly temporary trench interment may be necessary.

IX. Education, Instruction and Publicity.—Literature and special instructions will be necessary on many phases, including the following:

1. Instructions to physicians as to reporting, facilities available, district arrangements, etc.

2. Advice to physicians regarding treatment standards and suggestions.

3. Instructions for families, to be distributed by nurses, physicians, social workers, druggists, etc., covering the problems of care during the physician's absence.

4. Instructions to the public as to where aid may be secured, to be printed in various languages, and distributed by druggists, displayed in street cars, used in the press, etc.

5. Instructions for families on "What to do until the doctor comes."

6. Instructions to physicians, factory managers, school superintendents, etc., urging the necessity for immediate home and bed treatment at the first sign of respiratory disease.

7. Popular literature on the essentials of adequate care, the danger of returning to work too soon, etc. Popular press space is worth paying for, if it cannot be secured otherwise.

8. Popular publicity as to legitimate medical, nursing, undertaker, drug, and other charges, to prevent profiteering.

X. Miscellaneous.—1. The coöperation of pharmaceutical agencies should be secured to insure an adequate supply of drugs and druggists.

2. Influenza victims and their families should have "first call" on fuel deliveries.

3. While follow-up procedures are not legitimately a factor in the epidemic situation, their consideration is essential to an adequate meeting of the entire problem. This means adequate provision for

medical examination and nursing care, relief measures, industrial employment problems, the follow up of special sequelæ such as cardiac affections, tuberculosis, etc.

4. It is finally suggested that Health Department draw up a program based on the above outline, holding it in reserve for future use, if not immediately needed, and modifying the proposal to fit the size and other characteristics of the particular community.

The Bacteriology of the 1918 Epidemic of So-called Influenza.—The epidemic disease known as influenza is believed to be due to an undetermined organism which causes an infection that lowers the resistance of the body as a whole, and of the respiratory organs in particular. This allows the invasion of other pathogenic micro-organisms. The most important complicating infections are due to the influenza bacilli, different strains of pneumococci and different varieties of streptococci. Some careful observers regard certain of these organisms as the primary cause.

In each case, one or several of these microörganisms may be present. In different portions of the country the dominating variety of organism has been found to differ.

Vaccines.—Assuming that the cause of the epidemic is an unknown virus, it does not seem possible at present to prevent the primary disease by vaccination with known organisms. Against the secondary infections, there would seem to be a theoretical basis for the use of vaccines, and especially for the use of vaccines prepared from organisms responsible for complications which may differ in various localities at various times. This variable bacterial flora may militate against the practical application of vaccination on a large scale, because it would seem to require frequently repeated vaccinations with the flora that may be met with. It is impossible at present to evaluate the reports from the use of these vaccines adjusted to meet local conditions. More data obtained under carefully controlled conditions are needed.

Stock vaccines made from the influenza bacillus alone or from other bacteria, such as the fixed types of the pneumococci, have been used to considerable extent. The injections of stock vaccines have seemed to mitigate to some degree some outbreaks of influenza and also the severity of the complicating infections; but in those instances in which the results of the use of vaccine have been controlled, no appreciable results have been obtained. The fact that the vaccine is usually employed after the epidemic has broken out and is perhaps on a decline, and the fact that an unknown number of people have been exposed, make it very difficult to draw conclusions as to its efficacy.

Recommendations.—Your committee recommends that until such time as the efficacy, or the lack of efficacy, of prophylactic vaccination against influenza is established, vaccine if used, should be employed in a controlled manner, under conditions that will allow a fair comparison of the number of cases and of deaths among the vaccinated and non-vaccinated groups. Particular attention should be directed to

securing data as to the period in the epidemic at which vaccinated and non-vaccinated persons developed the disease.

Your committee is of the opinion that the indiscriminate use of stock vaccines against influenza and influenza and pneumonia cannot be recommended.

Nothing in these recommendations should be interpreted as discouraging the use of a pneumococcus stock vaccine against lobar pneumonia.

This epidemic emphasizes the importance of properly equipped laboratories.

PNEUMONIA (ACUTE LOBAR).

An acute infectious disease characterized by inflammation of the lungs and constitutional disturbance of varying intensely, in which the fever usually terminates abruptly by crisis. Secondary infectious processes and complications are frequent.

Pneumonia is one of the most prevalent and fatal of all acute diseases, rivalling and sometimes exceeding tuberculosis as a cause of death. It is most fatal in young adults and old persons, but no age or sex is exempt. The disease is apparently not decreasing in this country. Among the factors favoring the spread of the infection are overcrowding, and other influences of modern civilization which tend to diminish the vital resistance of the individual. Possibly more persons are now saved from the acute infections of childhood and early youth, moreover, to become later victims of pneumonia. One attack confers no immunity. This is probably due to the fact that lobar pneumonia may be due to a number of varieties of pneumococci, each one of which is affected by different antibodies. A case recovering from type I is probably more or less immune for some months at least to type I organisms, but such a case is not immune to type II, III or IV.

Since the influenza epidemic lobar pneumonias have much more frequently than heretofore been due to type IV organisms.

The disease has occurred in epidemic form, from time to time, in all parts of the world. Indeed, it may be properly considered to be pandemic.

Infectious Agent.—The infectious agent includes various pathogenic bacteria commonly found in the nose, throat and mouth, such as the pneumococcus, the bacillus of Friedländer, the influenza bacillus, etc.

Four groups or strains of pneumococci are now known to be the usual cause of lobar pneumonia, viz., I, II, III and IV. The first three groups cause in ordinary times about 80 per cent. of all cases and occur in healthy persons most often in the mouths of convalescents from the disease or of those in direct contact with cases.

Source of Infection.—The source of infection is the discharges from the mouth and nose of apparently healthy carriers as well as recognized infected individuals, and articles freshly soiled with such discharges.

Modes of Transmission.—The mode of transmission is by direct contact with an infected person, or with articles freshly soiled with the discharges from the nose or throat of, and possibly from infected dust of rooms occupied by, infected persons.

Incubation Period.—The incubation period is difficult to estimate, as the lobar pneumonia may occur in a carrier months after infection, if resistance is lowered. In an outbreak it is usually two to three days.

The period of communicability is unknown; presumably until the mouth and nasal discharges no longer carry the infectious organisms in an abundant amount or in a virulent form.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the Disease.*—Recognition of the disease by its clinical symptoms. The specific infecting agents may be determined by serological (agglutination) and bacteriological tests early in the course of the disease.

2. *Isolation.*—Isolation of the patient during the clinical course of the disease.

3. *Immunization.*—The results obtained in the mines of South Africa and in some of the army camps in Europe and America give some hope of a successful immunization against types I, II, and III. The U. S. P. S. is now carrying on extensive investigation in which every other inmate of a number of large institutions have been given some 5 billions of each of the three fixed types.

4. *Quarantine.*—None.

5. *Concurrent disinfection* of the discharges from the nose and throat of the patient.

6. *Terminal Disinfection.*—Thorough cleansing, airing and sunning.

II. General Measures.—In institutions and camps, when practicable, people in large numbers should not be congregated closely within doors.

The general resistance of the individual should be conserved by good feeding, fresh air, temperance in the use of alcoholic beverages, and other hygienic measures.

As carriers no doubt play an important part in spreading the infection, the education of the public concerning spitting, sneezing and coughing, etc., and the peril of the common drinking cup and roller towel and of placing unnecessary things in the mouth, should be actively continued.

BRONCHOPNEUMONIA.

The preventive measures are exactly the same as in lobar pneumonia except for the fact that the causal microörganisms are still more varied. Not only different varieties of pneumococci are frequently met with, but also streptococci and influenza bacilli. This makes the possibility of devising an effective vaccine almost hopeless.

ACUTE INFECTIOUS CONJUNCTIVITIS (NOT INCLUDING TRACHOMA).

This title is intended to replace the terms gonorrheal ophthalmia, ophthalmia neonatorum, babies' sore eyes, and other infectious eye troubles.

Infectious Agent.—The infectious agents are the gonococcus or some member of a group of pyogenic organisms including the hemoglobinic bacilli.

Source of Infection.—The source of infection is the discharges from the conjunctivæ, or genital mucous membranes of infected persons, or with articles soiled by discharges.

Mode of Transmission.—The modes of transmission are by contact with an infected person or with articles freshly soiled with discharges of such person.

Incubation Period.—The incubation period is irregular, but usually thirty-six to forty-eight hours.

Period of Communicability.—The period of communicability is during the course of the disease and until the discharges from the infected mucous membranes have ceased.

Methods of Control.—1. *Concurrent disinfection* of the conjunctival discharges and articles soiled therewith.

General Measures.—1. Enforcement of regulations forbidding the use of common towels and toilet articles. Education as to personal cleanliness.

2. The use of a solution of silver nitrate in the eye of the newborn (Crede's method).

TRACHOMA.

Trachoma (**Granular ophthalmia**) is the name given to an infectious process in the eye, characterized by slowly progressive changes in the conjunctiva and subconjunctival tissue, threatening the integrity of the eyesight. A number of observers doubt the clinical entity of this process.

So serious, however, are the results of chronic inflammation of the membranes of the eyelids, that all immigrants arriving in the United States have their eyelids everted and conjunctivæ examined for evidence of such an infection; and when found to be infected such aliens are deported, a penalty of $100 being exacted from the steamship that brings them in. For this reason, and because of improved sanitary surroundings in this country, trachomatous inflammations are less common here than they used to be. Such inflammations thrive best in unsanitary surroundings, and prevail more or less in the poorer sections of all large cities. When once well established permanent cures are doubtful.

Infectious Agents.—The infectious agent has not been definitely determined, but the chief agents are thought to be the hemoglobinic bacilli including the so-called "Koch-Weeks" bacillus.

Source of Infection.—The source of infection is the secretions and purulent discharges from the conjunctivæ and adnexed mucous membranes of the infected persons.

Mode of Transmission.—The mode of transmission is by direct contact with infected persons and indirectly by contact with articles freshly soiled with the infectious discharges of such persons.

Incubation Period.—The incubation period is undetermined.

Period of Communicability.—The period of communicability is during the persistence of lesions of the conjunctivæ and of the adnexed mucous membranes or of discharges from such persons.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the Disease.*—Recognition of the disease is by the clinical symptoms, assisted by bacteriological examination of the conjunctival secretions and lesions.

2. *Isolation.*—Exclusion of the patient from general school classes, unless the dangers of contact can be eliminated.

3. *Immunization.*—None.

4. *Concurrent disinfection* of discharges and articles soiled therewith.

II. General Measures.—1. *Search for Cases.*—Search for cases by examination of school children, of immigrants and among the families and associates of recognized cases; and in addition, search for acute secreting diseases of the conjunctiva and adnexed mucous membranes both among school children and in their families, and treatment of such cases until cured.

2. *Elimination.*—Elimination of common towels and toilet articles from public places.

3. *Education of the Public.*—Education of the public in the principles of personal cleanliness and the necessity of avoiding direct or indirect transference of body discharges.

4. *Control of Public Dispensaries.*—Control of public dispensaries where communicable eye diseases are treated.

TUBERCULOSIS.

Tuberculosis is one of the most widespread and fatal of diseases. It is the cause of death of about 9 per cent. of those dying from all causes in this country. It is conservatively estimated that more than 160,000 persons in the United States die each year of tuberculosis and most of these in the period of life of greatest usefulness, that is, between the ages of fifteen and forty-five years. Not only does this disease consume the vital forces of the individual, disabling him for several years, perhaps, previous to death, but it destroys for the most part, the material prosperity of the family of the person it attacks. The money cost of tuberculosis, therefore, including capitalized earning power lost by death, has been estimated to exceed a billion dollars annually, two-fifths of which falls on others than the consumptive.

Only gradually have we learned to appreciate the true proportions of this apparently uninfected community that has been attacked.

According to the evidence of postmortem findings by various

pathologists, a very large number of the bodies examined of persons who died of other diseases than tuberculosis show scars of old tuberculous processes, in some places as many as 90 per cent. The majority of all persons more than a few years of age give the von Pirquet cutaneous reaction for tuberculosis. This has been tried in such multitudes of cases and under such varied conditions that we cannot doubt that nearly everone in civilized communities has at sometime slight lesions and that many have this latent infection at all times.

There are several types of the tubercle bacillus causing the disease, of which the human and bovine types are the most important. These two varieties resemble each other very closely, the essential difference between them being that the human type is pathogenic for man but has little effect on cattle, rabbits, monkeys and other animals (except young guinea-pigs, which are very susceptible to human tuberculosis); while the bovine type is pathogenic for almost all mammalian animals. It is also pathogenic for man, but less so than the human bacillus. The widespread existence of the disease in cattle, from which we derive nearly all the milk, renders the bovine bacilli an important etiological factor in connection with tuberculosis in children.

No age, sex or race is immune from the disease. The Indian and the Negro races of this continent are particularly susceptible. Tuberculosis exists in all countries, but it is most prevalent wherever the population is crowded together. Although caused specifically by the tubercle bacillus, such conditions as are brought about by poverty, poor food, bad housing, overwork, worry, intemperance, etc., act as contributing causes in the production of the disease; while among the well-to-do and prosperous who can afford to buy good food, rest and recreation, and life in the open, these more wholesome conditions increase the vital resistance and enable them to avoid contact with the infection.

A close study of tuberculosis indicates that the number of cases and deaths per 100,000 of the population began to lessen in those countries in which prosperity of the industrial workers improved even before the discovery of the tubercle bacillus. If nearly every one of us becomes infected at some time and yet less than one-tenth develop serious tuberculosis then it is certain that disease depends not so much upon infection but upon some other factors, especially such as show hunger and other infections which lessen resistance. How frequently following overwork, a cold, personal dissipation or childbirth a latent focus flares up.

As Kraus has stated, anything that leads to an amelioration of the general habits and conditions of life of masses of people will work toward a subsidence of tuberculosis.

Infection.—Infection in tuberculosis takes place usually through the respiratory tract or the digestive tract, including the pharynx and tonsils; more rarely through wounds of the skin. It is produced chiefly by the direct transmission of tubercle bacilli to the mouth through soiled hands, lips, handkerchiefs, food (milk, etc.), or by the inhalation of fine particles of mucus thrown off by coughing or loud speaking, or of tuberculous dust contaminated by sputum or feces.

When the skin or mucous membranes are superficially infected through wounds there may develop lupus, ulceration, or a nodular growth. The latter two forms of infection are apt after an interval to cause the involvement of the nearest lymphatic nodes.

The lungs are the most frequent location of clinically recognizable tuberculous inflammation. Most of the inhaled bacilli are caught upon the nasal or pharyngeal mucous membranes, a few of these may be caught in the tonsil or crypts or elsewhere but the great majority are swallowed. Some of these are destroyed, some pass with the feces and the remainder are absorbed. The last may be destroyed or cause the infection of the nearest lymph gland or pass along and enter the blood and be carried to a bronchial lymph node or elsewhere. In the infant blood infection is apt to be followed by generalized tuberculosis while in the adult this is apt to be localized. Only a small percentage can find their way directly to the trachea, and still less to the larger and smaller bronchioles.

Dried and Moist Sputum.—A common mode of infection is by means of tuberculous sputum, which, being coughed up by consumptives, is either disseminated as a fine spray (droplet infection) and so inhaled, or, carelessly expectorated, dries and, broken up by tramping over it, sweeping, etc., distributes numerous virulent bacilli in the dust (dust infection). As long as the sputum remains moist there is no danger of dust infection; it is when it becomes dry, as on handkerchiefs, bedclothes, or the floor, etc., that the dust is a source of danger.

A great number of the expectorated and dried tubercle bacilli undoubtedly die, especially when exposed to the action of direct sunlight, but when it is considered that as many as 5 billion virulent bacilli may be expectorated by a single individual in twenty-four hours, it is evident that even a much smaller proportion than are known do stay alive will suffice in the immediate vicinity of consumptives to communicate the organism unless precautions are taken to prevent it. The danger is greatest, of course, in the close neighborhood of tuberculous patients who expectorate profusely and indiscriminately, that is, without taking necessary means of preventing infection. There is much less danger of infection in the streets, for instance, where the bacilli have become diluted. In rooms the sputum is not only protected from the direct sunlight, but it is constantly broken up and blown about by the walking, etc. In crowded streets on windy days it is reasonable to suppose that infected dust must sometimes be in the air unless the expectoration of consumptives is controlled.

On the whole, it may be said that the danger of infection of the adult from contact with the tuberculous is not so great as it is considered by many. Those who are most liable to infection from this source are especially infants and young children who have not become partially immunized through earlier slight infections. In this connection, also, attention may be drawn to the fact that rooms which have been recently occupied by consumptives are not infrequently the means of producing infection from the deposition of tuberculous dust on furniture, walls, floors, etc. The danger

is not apt to last beyond three months, although a few live bacilli may be detected in sheltered places for a year. Flügge has shown that in coughing, sneezing, etc., very fine particles of throat secretion containing bacilli are thrown out and carried by air currents many feet from the patient and remain suspended in the air for a considerable time. To encourage us, however, we now have a mass of facts which go to prove that when the sputum is carefully looked after there is very little danger of infecting others except by close personal contact.

Ingestion infection.—Milk serves as a conveyor of infection, whether it be the milk of nursing mothers or the milk of tuberculous cows. In this case the evidence of infection is usually shown in the mesenteric and cervical lymph nodes, or generalized tuberculosis may be caused, while the intestinal walls are frequently not affected. Bacilli accompanied by fat pass readily through the intestinal mucous membrane or that of the tonsils and pharynx.

Formerly it was thought that in order to produce infection by milk there must be a local tuberculosis affection of the udder. But it is now known that while this is usually so, nevertheless tubercle bacilli may be found in the milk in small numbers, when adjacent tissue is infected, and when there is apparently no udder disease. It has also been shown that the feces are a very dangerous factor in the dissemination of tubercle bacilli from cows. Butter, too, may contain tubercle bacilli in considerable numbers, as the butter is stored the bacilli gradually die. When we consider the prevalence of tuberculosis among cows we can readily realize that even if the bovine bacillus is not very pathogenic for man, there is great danger to children who are constantly exposed to this source of infection. The milk from cows suffering from udder tuberculosis usually contains several hundred bacilli per c.c., but may contain many million. The mixed milk from a herd, therefore, tending to dilute the milk of cows excreting tubercle bacilli, may be badly infected from one cow, especially if this cow has udder disease. Bacilli have been found in from 10 to 30 per cent. of samples of city milk examined.

About 10 per cent. of the cattle slaughtered in various countries have been found to be tuberculous. But the danger of infection from eating the meat of tuberculous cattle is very slight. This is owing to the fact that the meat is usually cooked thoroughly before eating, and because the muscular tissues are seldom involved.

Bovine Infection in Man.—Numerous investigations made on this point have abundantly shown that such infection does take place. As the result of a large series of cases reported by ourselves and others, it has been shown: (1) That children are especially infected, and usually the point of entry is the alimentary tract; (2) that cervical adenitis and abdominal tuberculosis are the most frequent types of infection; (3) that generalized tuberculosis due to bovine infection is less frequent; (4) that bone and joint tuberculosis is most commonly of the human type; (5) that the meninges are less commonly affected by the bovine than the human type; (6) that the infection of adults is very infrequent; and (7) that though cases of pulmonary tuberculosis

due to the bovine type of bacillus have been reported, such cases are rare.

A careful study of all the factors lead us to estimate that about 10 per cent. of all deaths caused by tuberculosis in children under five years of age is due to bovine infection when the milk is not pasteurized. The following two tables summarize the results:

COMBINED TABULATION, CASES REPORTED AND OWN SERIES OF CASES.

Diagnosis.	Adults sixteen years and over.		Children five to sixteen years.		Children under five years.	
	Human.	Bovine.	Human.	Bovine.	Human.	Bovine.
Pulmonary tuberculosis	568	1(?)	11	..	12	
Tuberculous adenitis, axillary or inguinal	2	..	4	..	2	
Tuberculous adenitis, cervical	22	1	33	20	15	20
Abdominal tuberculosis	15	3	7	7	6	13
Generalized tuberculosis, alimentary origin	6	1	2	3	13	10
Generalized tuberculosis	28	..	4	1	28	5
Generalized tuberculosis, including meninges, alimentary origin	..	..	1	..	3	8
Generalized tuberculosis, including meninges	4	..	7	..	45	1
Tubercular meningitis	..	..	2	..	14	2
Tuberculosis of bones and joints	18	1	26	1	21	..
Genito-urinary tuberculosis	11	1	1	..	..	
Tuberculosis of skin	1	..	1	..	1	
Miscellaneous cases:						
Tuberculosis of tonsils	..	..	..	1		
Tuberculosis of mouth and cervical nodes	..	1				
Tuberculous sinus or abscesses	2					
Sepsis, latent bacilli	..	..	..	..	1	
Totals	677	9	99	33	161	59

Mixed or double infection, 4 cases.
Total cases, 1042.

We have arranged the cases included in the tables so as to show the percentage of bovine infection according to the main types of disease and the age of the individuals infected. These are as follows:

PERCENTAGE OF BOVINE INFECTION.[1]

Diagnosis.	Adults sixteen years and over.	Children five to sixteen years.	Children under five years.
Pulmonary tuberculosis	[2]0 per cent.	0 per cent.	0 per cent.
Tuberculous adenitis, cervical	4 "	37 "	57 "
Abdominal tuberculosis	16 "	50 "	68 "
Generalized tuberculosis	3 "	40 "	26 "
Tubercular meningitis (with or without generalized lesions)	0 "	0 "	15 "
Tuberculosis of bones and joints	5 "	3 "	0 "

[1] Exclusive of the cases of double infections. In considering the pulmonary cases it must be remembered, however, that bovine tubercle bacilli have been isolated from the lung in cases of generalized tuberculosis in children.

[2] If one doubtful case admitted, 0.2 per cent.

Susceptibility.—It was formerly believed that in demonstrating that tuberculosis was caused by a specific bacillus its occurrence was adequately explained; but it is now known that there is another important factor in the production of this and other infectious diseases, viz.: individual susceptibility. At first the inherited susceptibility was thought to be more important than the acquired, but now much that was attributed to the former is known to be explained by the fact of living in an infected area. The acquired susceptibility may arise from faulty physical development or from depression, sickness, child-bearing, overwork, strain of any kind, excessive use of alcohol, etc., which lowers the resistance of the individual. Unquestionably great differences exist in different persons in the intensity of the tuberculous processes. That this does not depend upon a difference of virulence of the infection is evident from the fact that individuals contracting tuberculosis from the same source are attacked with different severity, and that there is, as a rule, no great difference in degree of virulence for animals in the tubercle bacilli obtained from different sources. Clinical experience teaches, likewise, that good hygienic conditions, pure air, good food, freedom from care, etc., increases immunity to tuberculosis. Animal experiments have shown that not only are there differences of susceptibility in various species, but also in individual susceptibility in the same species and that this can be lowered by subjecting the individuals under test to strains. The doctrine of individual susceptibility is therefore seen to be founded in fact, although the reasons for it are as yet only partially understood.

Immunity.—The great majority of mankind has, in varying degree, a natural immunity against tuberculosis. In many individuals, however, this immunity is only relative and is maintained only as long as the health is kept at a high standard or the exposure to infection is not too intense or prolonged.

Most of us become infected during the early years of life, and a large part of such infections remain latent. As long as these latent lesions exist and the general resistance is good, a relative immunity to reinfection persists. Should, however, this immunity be lowered by some factor as an infectious disease, exposure, fatigue, etc., dissemination occurs, which then progresses, or in turn with recovery of the general bodily resistance, regresses and the immunity again rises and protection is reëstablished.

We may therefore conclude that childhood is the most frequent time of infection, that the disease in later life is usually an auto-infection from the lesions so acquired, and that most adults have little reason to fear contact infection.

Nevertheless, the precautions now taken should not be relaxed for there are some persons who, because of the complete healing of a previously existed lesion or having escaped infection, are susceptible. There is reason to believe, however, that those who have lost their immunity through the complete healing of their lesions are on the average more protected than those who have escaped infection.

Should they become reinfected they would probably reëstablish their immunity more promptly and thus limit or destroy the bacilli which found entry.

As in other infectious diseases many attempts have been made to produce an artificial immunity against tuberculosis, but so far the results have been disappointing. There is little at first glance in the clinical history of tuberculosis to show that acquired immunity occurs, since relapse is the rule. For this reason, the production of an artificial immunity against tuberculosis has been looked upon by many as a result possibly incapable of achievement. The careful study of tuberculosis seems, however, to indicate an attempt on the part of Nature for the production of an acquired immunity. The inoculation of living cultures or of toxins and dead bacilli (as in Koch's tuberculin and other preparations) is an effort to imitate Nature's method of immunization.

Tuberculin has not proved to be a cure for tuberculosis. It does promote healing, however, and relapses are less frequent after its use; but it should be used as an addition to, not as a substitute for, the recognized methods of treatment, and it should be employed only by those who have a thorough understanding of its possibilities for good, and, unfortunately also, in inexperienced hands for harm.

The Institutional Care of the Tuberculous.—If it is impossible to reduce the spreaders of tubercle bacilli to an extent that will prevent practically every one receiving frequently tubercle bacilli and at some time becoming infected can we consider the sanatorium as now developed or its future possibilities as a hopeful measure of eliminating tuberculosis?

This does not seem plausible. The great value of institutional care is to restore to complete or partial health those who have developed tuberculosis. Unquestionably the education and temporary removal of so many will prevent a considerable number of infants and young children and some adults from becoming infected at inopportune times. This removal of infection may amount to more than we now think. The unusual prevalence of clinical tuberculosis among children in tuberculous families indicates that personal contact with open cases is much more dangerous than the accidental infection from contact at play and school.

Summary.—Source of Infection.—The source of infection is the specific organism present in the discharges, or articles freshly soiled with the discharges from any open tuberculous lesions, the most important discharge being sputum. Of less importance are discharges from the intestinal and genito-urinary tracts or from lesions of the lymphatic glands, bone and skin.

Mode of Transmission.—The mode of transmission is by direct or indirect contact with an infected person by coughing, sneezing, or other droplet infection, kissing, common use of unsterilized food utensils, pipes, toys, etc., and possibly by contaminated flies and dust.

Incubation Period.—The incubation period is variable and dependent upon the type of the disease.

Period of Communicability.—The period of communicability exists as long as the specific organism is eliminated by the host. It commences when a lesion becomes an open one, and continues until it heals or death occurs.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the Disease.*—Recognition of the disease by the clinical symptoms and by thorough physical examination, confirmed by bacteriological examination and by serological tests.

2. *Isolation.*—Isolation of such "open" cases as do not observe the precautions necessary to prevent the spread of the disease.

3. *Immunization.*—None efficient.

4. *Quarantine.*—None.

5. *Concurrent Disinfection.*—Concurrent disinfection of sputum and articles soiled with it. Particular attention should be paid to prompt disposal or disinfection of the sputum itself, of handkerchiefs, cloths, or paper soiled therewith, and of eating utensils used by the patient.

6. *Terminal Disinfection.*—Renovation.

II. General Measures.—1. *Education of the Public.*—Education of the public in regard to the dangers of tuberculosis and the methods of contact, with especial stress upon the danger of exposure and infection in early childhood.

2. *Provision of Dispensaries.*—Provision of dispensaries and visiting-nurse service for the discovery of early cases and the supervision of home cases.

3. *Provision of Hospitals.*—Provision of hospitals for isolation of advanced cases and sanatoria for the treatment of early cases.

4. *Provision of Open-air Schools.*—Provision of open-air schools and prevention for pre-tuberculous children.

5. *Improvement of housing conditions* of the poor.

6. *Ventilation and elimination of dust* in industrial establishments and places of public assembly.

7. *Improvement of habits of personal hygiene* and betterment of general living conditions.

8. *Separation at birth of babies* from tuberculous mothers.

Pasteurization to render the general milk supply safe.

LEPROSY.

Leprosy is one of the oldest of known diseases and it still prevails widely in hot countries, such as India, China, Japan and South Africa. In Europe, where it prevailed in epidemic form in the middle ages, it has become almost unknown except in Norway, Sweden, Finland, Russia, Turkey, Spain, Italy and Greece. There are a large number of cases in the Philippine Islands, the Hawaiian Islands and some in Guam and Porto Rico. On this continent leprosy exists in the Gulf

States, among the orientals on the Pacific Coast, and extensively in Mexico.

The disease attacks all classes and persons of all ages. Males are more frequently affected than females, apparently. It is probably always communicated directly from the sick to the well, but close, intimate and prolonged association with a leprosy patient seems necessary to contract the infection. Not only is the disease not nearly so contagious as was popularly supposed but the conditions met with in civilized nations and amid modern sanitary surroundings are unfavorable to its spread.

In many respects leprosy is similar to tuberculosis. This relation between the two diseases is rendered still more remarkable by the fact that leprosy reacts, both locally and generally, to an infection of tuberculin in the same manner as tuberculosis, but to a somewhat less extent. Like tuberculosis, leprosy is not always fatal but may be treated in the same way with possibility of curtailment.

Infectious Agent.—The infectious agent is the bacillus lepræ, found in all the diseased parts and usually in large numbers, especially in the tubercles on the skin, in the conjunctiva and cornea, the mucous membranes of the mouth, gums and larynx, and in the intestinal processes of the nerves, testicle and spleen, liver and kidneys.

Source of Infection.—The source of infection is the discharge from lesions.

Mode of Transmission.—The mode of transmission is by close, intimate and prolonged contact with infected individuals. Flies and other insects may possibly act as mechanical carriers.

Incubation Period.—The incubation period is prolonged and undetermined.

The Period of Communicability.—Infectivity exists throughout the duration of the disease, but under ordinary circumstances this disease is but slightly communicable.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the Disease.*—Recognition of the disease by the clinical symptoms, confirmed by bacteriological examination.

2. *Isolation.*—Isolation for life in national leprosorium when this is possible.

3. *Immunization.*—None.

4. *Quarantine.*—None.

5. *Concurrent disinfection* of discharges and articles soiled with them.

6. *Terminal Disinfection.*—Thorough cleansing of living premises of the patient.

II. General Measures.—1. Lack of information as to the determining factors in the spread and communication of the disease makes any but general advice in matters of personal hygiene of no value.

2. As a temporary expedient, lepers may be properly cared for in local hospitals, or if conditions of the patient and his environment warrant, he may be allowed to remain on his own premises under suitable regulations.

CEREBROSPINAL MENINGITIS.

This is a specific infectious disease, occurring sporadically and in epidemics, characterized by inflammation of the cerebrospinal meninges and a clinical course of great irregularity.

Infective Agent.—The infective agent of epidemic meningitis is the diplococcus intracellularis meningitidis (meningococcus). But not all cases of meningitis are caused by the meningococcus. Sporadic cases may be due to the pneumococcus, streptococcus, bacillus of influenza, the colon bacillus, the typhoid bacillus, the bacillus of bubonic plague and of glanders. The gonococcus may also cause meningitis as a secondary infection. The epidemic form of cerebrospinal meningitis is probably always due to the meningococcus.

Incidence.—The epidemics have occurred most frequently in winter and spring, thus corresponding to the seasonal prevalence of pneumonia and influenza, and other infectious diseases spread by discharges of the respiratory tract, but differing in this respect from infantile paralysis, the epidemics of which have occurred most frequently in the summer months (July to September).

Neither soil nor locality has any special influence. Overcrowding and concentration of individuals, as in living quarters and public places in cities, and in large barracks, camps or on shipboard, seem to favor the incidence of the disease.

Children and young adults are most susceptible, though the susceptibility has differed in different epidemics; it also varies in the individual. Males and females are equally attacked. Certain epidemics have been most prevalent in country districts. One attack does not confer lasting immunity.

Source of Infection.—The source of infection is the discharge from the nose and mouth of infected persons. Clinically recovered cases, and healthy persons who have never had the disease but have been in contact with cases of the disease or other carriers, act as carriers and are commonly found, especially during epidemics. Such healthy carriers are not uncommonly found independent of epidemic prevalence of the disease.

Mode of Transmission.—The mode of transmission is by direct contact with infected persons and carriers, and indirectly by contact with articles freshly soiled with the nasal and oral discharges of such persons.

Incubation Period.—The incubation period is from two to ten days, commonly seven; occasionally for longer periods when a person is a carrier for a time before developing the disease.

Period of Communicability.—The period of communicability is during the course of the disease and until the specific organism is no longer present in the nasal and mouth discharges of the patient. The same applies to healthy carriers so far as affects persistence of infecting discharges.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the Disease.*—Recognition of the disease by its

clinical symptoms, confirmed by the microscopic and bacteriological examination of the spinal fluid and by bacteriological examination of nasal and pharyngeal secretions.

2. *Isolation.*—Isolation of infected persons and carriers until the nasopharynx is free from the infecting organism, or, at the earliest, until one week after the fever has subsided.

3. *Immunization.*—Immunization may prove of value, although the use of vaccines for immunization is still in the experimental stage.

4. *Concurrent Disinfection.*—Concurrent disinfection of discharges from the nose and mouth and of articles soiled therewith.

5. *Terminal Disinfection.*—Cleansing.

II. General Measures.—General measures for the prevention of cerebrospinal meningitis, though plainly indicated, are extremely difficult to carry out effectively. These consist of

1. *Search for Carriers.*—Search for carriers among families and associates of recognized cases by bacteriological examination of the posterior nares of all contacts. Only a thoroughly trained technician can be trusted to isolate the meningococcus, and even such a one will frequently miss them when they are few in number. Cultures from the nasopharynx are most liable to reveal them.

2. *Education of the public* as to personal cleanliness, washing of the body daily and of the hands in soap and water before eating, keeping hands and unclean articles away from mouth, nose, etc., avoiding the use of common or unclean eating drinking or toilet articles of any kind, avoiding direct exposure to the spray from the nose and mouths of people who cough or sneeze, etc., and the necessity of avoiding contact infection.

3. *Prevention of overcrowding,* such as is common in living quarters, transportation conveyances, working places and places of public assembly in the civilian population, and in inadequately ventilated barracks, camps and ships among military units.

Antimeningitis serum is useful in the treatment of the disease, but it is not practical as a preventive measure so far as it has been tested.

POLIOMYELITIS (INFANTILE PARALYSIS).

Poliomyelitis is an acute infectious disease, occurring sporadically and in epidemics, characterized by symptoms of a general infection, with the lesions most marked in the central nervous system. The clinical manifestations exhibit a widespread and scattered motor paralysis or weakening.

Incidence.—Although poliomyelitis has in the last few years assumed a special importance because of its increasing prevalence, particularly in the United States, it has been known for many years in various parts of the world, especially in Scandinavian countries.

Formerly it was looked upon as a rural disease, but most of the recent epidemics have occurred in cities, although not in the crowded parts of cities. Social conditions and sanitary surroundings apparently

have no influence whatever on the incidence or spread of the infection. In New York City in 1907 there was an epidemic of over 2000 cases, and again in 1916 of nearly 9000 cases (the largest epidemic ever recorded and giving a case mortality of 26.9 per cent.).

No age, sex or race is exempt, but the majority of cases occur among children under five years of age. Males appear to be more susceptible than females. One attack of the disease confers a high degree of immunity, but recurrent and second attacks have been reported.

Infectious Agent.—This is constantly present in the brain and in the mucous membrane of the nose and pharynx, the mesenteric and inguinal glands, and in the intestinal secretions.

Source of Infection.—The source of infection is the nose, throat and bowel discharges of infected persons or articles recently soiled therewith. Healthy carriers are supposed to be common.

Mode of Transmission.—The mode of transmission is by direct contact with the infected person or with a carrier of the virus, or indirectly by contact with articles freshly soiled with the nose, throat or bowel discharges of such persons.

Other modes of transmission have been suspected, as for instance certain flies and insects from the similarity of the disease to an insect bowel infection, dust, food, etc.; but none of these theories have been corroborated by actual experience.

Incubation Period.—The incubation period is from three to ten days, commonly six days.

Period of Communicability.—The period of communicability is unknown; apparently not usually more than twenty-one days from the onset of the disease.

Methods of Control.—These can be tentative only until the mode of transmission of the disease is more definitely known.

I. The Infected Individual and his Environment.—1. *Recognition of the Disease* by its clinical symptoms, assisted by chemical and microscopical examination of the spinal fluid.

2. *Isolation* of all recognized cases.

3. *Immunization.*—None.

4. *Quarantine* of exposed children of the household and of adults of the household whose vocation brings them into contact with children, or who are food handlers, for fourteen days from the last exposure to a recognized case.

5. *Concurrent Disinfection* of nose, throat and bowel discharges and articles soiled therwith.

6. *Terminal Disinfection.*—Cleansing.

II. General Measures.—1. *Search for and examination* of all sick children should be made as far as possible.

2. *All children with* fever should be isolated pending diagnosis.

3. *Education in such technic* of bedside nursing as will prevent the distribution of infectious discharges to others from cases isolated at home.

DIPHTHERIA.

The lesions of diphtheria are caused by toxemia. The concentrated poison at the seat of the exudate causes intense local inflammation, while in the more severe cases the absorbed poison diffused throughout the body produces widespread cellular injury, giving rise to definite injury of the cells of the muscle, nerve and other tissues.

The disease is endemic in the larger centers of population, and becomes most active in the late fall and winter months. While the seasonal prevalence is in the colder months, an epidemic when once established may occasionally run into the summer, regardless of the season. Damp dwellings favoring colds and sore-throats, as other depressing influences may predispose to the infection. There is no relation, except for the effect of bad smells and the toxic gas, however, between imperfect drains and sewer gas and the cause of diphtheria, as has been popularly supposed. Of the predisposing causative factors age is one of the most important. Infants under six months are rarely attacked, the majority of cases occurring between the beginning of the second and the tenth years. Adults are not infrequently affected.

MORTALITY ACCORDING TO AGES FROM DIPHTHERIA IN CITIES AS EXEMPLIFIED IN NEW YORK CITY, 1891–1900

Ages.	Number.	Per cent.
Under six months	555	3.0
6 months to 1 year	1,110	6.0
1 to 2 years	4,263	23.0
2 to 3 "	3,817	21.2
3 to 4 "	2,900	16.1
4 to 5 "	1,908	10.6
Under 5 "	14,553	81.5
5 to 10 "	3,052	17.0
10 to 15 "	241	1.3
Over 15 years	35	0.2

The immunity conferred by an attack of diphtheria varies in different individuals; it usually persists for some months or years. In most cases recovery is due to the development of bactericidal bodies rather than antitoxin. Cases which have not received antitoxin show a positive Schick test after recovery in about 75 per cent. When second and even third attacks are investigated they are usually found to be some other throat infection; that many persons enjoy a high degree of immunity, due to antitoxin or other antibodies in the blood, is shown by the fact that they may harbor virulent bacilli in their throats for a long time without contracting the disease.

The individual susceptibility to diphtheria also varies greatly. The presence or absence of susceptibility to or immunity against the disease in any individual may be readily determined by the Schick test, which tells whether antitoxin is present or absent in the blood of that individual. Those showing a negative test are immune. Those showing a positive test have no antitoxin immunity, but may have a bactericidal immunity.

Infecting Agent.—The infectious agent is the bacillus diphtheria (the Klebs-Loeffler bacillus).

Source of Infection.—The source of infection is the discharges from diphtheritic lesions of the nose, throat, conjunctiva, vagina and wound surfaces; and secretions from the nose and throats of the bacillus carriers.

Mode of Transmission.—The mode of transmission is directly by personal contact, indirectly by articles freshly wet with discharges, or through infected milk or milk products.

Incubation Period.—The incubation period is usually two to five days, occasionally longer if a healthy carrier stage precedes the development of clinical symptoms.

Period of Communicability.—The period of communicability is until the virulent bacilli have disappeared from the secretions and the lesions. The persistence of the bacilli after the lesions have healed is variable. In fully three-fourths of the cases they disappear within two weeks.

Prevention.—Diphtheria, like other infections of the respiratory tract has shown an irregular increase during the past century. This was probably due to the increasing concentration of people in great cities with the accompanying added risk of infection from contact with carriers of diphtheria bacilli. These infected persons we now know to have been not only actual or recently recovered cases, but healthy people who had become carriers. The disease first appeared in countries in the form of epidemics, but later remained more or less prevalent throughout years.

With the discovery of the diphtheria bacillus and the use of diagnostic cultures, it seemed at first that this tendency to increase would be stopped and that a marked diminution would follow since it would be possible to carry out the more general and accurate isolation of the true cases of diphtheria whether mild or severe. New York City began the general employment of diagnostic cultures in the fall of 1893. The city had had for the two previous years a steadily increasing number of cases. The results were disappointing. In spite of the general use of cultures for isolation and discharge the amount of diphtheria did not diminish. The reasons for this soon became evident. These were partly dependent on the failure of cultures to always reveal bacilli in convalescent cases when only a few were present in the throat as in a crypt of the tonsils and partly on the great number of healthy persons who were carriers and who could not be cultured. It was soon discovered that not only the convalescent cases remained carriers for from a few days to many weeks, but that persons in contact with them frequently became carriers without developing the slightest disease and that those in turn infected others, who might themselves become carriers or true cases. The number of carriers was indicated in tests such as the following, a single swabbing of the tonsils revealed the presence of virulent bacilli in over 1 per cent. of 1000 healthy school children examined.

The technical difficulties which would be encountered in culturing a whole population and the disturbance of life that would follow the isolation of all healthy carriers made it impracticable to even attempt to clear masses of people from infection. In institutions, schools and families, however, attempts have frequently been made to detect and remove carriers. The results have sometimes been successful, but more often they have failed. The general outlook in 1899 was not encouraging. Just at the time this knowledge had been acquired the discovery of diphtheria antitoxin renewed hope for the ultimate conquest of the disease. The drop in deaths following its use was remarkable in every city and was always coincident with the introduction of antitoxin and this improvement has not only been held during the twenty-four years of its use, but until recently this improvement has grown greater, so that there cannot be any doubt in any candid and enlightened mind of the cause. At the present time New York City instead of an average death-rate of about 150 per 100,000 in the decade before 1895 has one of about 22. The influence of antitoxin upon the mortality and morbidity due to diphtheria was twofold. If 1000 units were given at the time of exposure then antitoxin gave absolute protection in all persons for ten days and in most for three weeks. Each repetition of the injection gave an added period of safety of from seven days to one week. The short duration of the protection is due to the fact that the antitoxin was produced in a horse and as a horse product it is a foreign protein in man and it is therefore rather quickly eliminated.

An interesting experiment was carried out some time ago which prettily demonstrated this. We possessed in addition to our regular product some diphtheria antitoxin produced in guinea-pigs and some in goats. We injected each of one series guinea-pigs with ten units of guinea-pig produced antitoxin, another series with ten units of horse antitoxin and a third series with ten units of goat antitoxin. At the end of two weeks examples of each series withstood two fatal doses of toxin. At the end of three weeks only examples of guinea-pigs from the lot receiving the guinea-pig antitoxin remained protected. This lot did not lose immunity till after six months. The second injection of the antitoxin is eliminated even more quickly. This is due probably to the development of antiferments to the horse antitoxin globulin. The use of antitoxin immunizing injection has been very effectual in infected families and institutions. The first trial in this country was most instructive. An institution caring for several hundreds of young children became infected with diphtheria. Each day one to six new cases appeared. The inmates were cultured again, but always some would escape detection or new cases would be infected during the period of the incubation of the cultures. When some weeks had elapsed Dr. Biggs brought over a considerable supply of antitoxin from Europe. It was determined to give every child 300 units of antitoxin. All the children received it the same day. The outbreak stopped absolutely. On the 12th day a doubtful case developed. A

second injection was given. No more cases occurred. I have never seen the use of an immunizing dose of antitoxin to fail for the period the antitoxin remains in the body. As over 50 per cent. of the cases of diphtheria occur in persons not known to have been exposed to cases, no amount of thoroughness of giving immunizing injections to those exposed could be expected to eliminate the greater proportion of cases now occurring in large centers of population. The use of immunizing injections must be supplemented therefore by its use in treatment.

Those that die from diphtheria do so either from the direct toxin effects or from the injury caused by the invasion of other bacteria which have gained a foothold on account of the lowered resistance due to injury from the diphtheria poisons. The diphtheria antitoxin acts only on the toxin. It should be given therefore at the earliest possible moment and in sufficient amount. As a subcutaneous or intramuscular injection is slowly absorbed, it is necessary to give antitoxin intravenously in serious cases. As it remains in the blood for a number of days one injection suffices. There is no harm in giving several provided that sufficient dose is given the first time.

The use of antitoxin has little if any effect in freeing carriers from diphtheria bacilli. They remain imbedded in some crypt of the tonsils or other inaccessible place. Suitable antiseptics are for the same reason of little value. Irritating antiseptics do harm. Diphtheria antitoxin for the previously mentioned reasons has had more effect on the mortality from diphtheria than on its prevention. The number of cases in each 1000 of the population has not decreased over one-third. During the past few years there has been less and less improvement. It is probable that with the help of the medical profession the people may be brought to report cases more promptly and to allow immunization more generally than they do now. If so a further slight improvement in mortality and morbidity may be obtained. There will nevertheless remain, unless all signs fail, a large number of cases and a considerable number of deaths unless we can produce in the susceptible portion of the population a durable immunity.

The Schick Reaction and Its Practical Application.—The results of combined clinical and laboratory experience in testing the blood for antitoxin in cases of diphtheria and in persons in contact with diphtheria have shown that only those individuals contract diphtheria who have no antitoxin or only a minute amount in their blood and tissues. Schick, in 1913, published a description of a simple clinical test by which this can be accurately accomplished. The reaction depends on the local irritant action of minute quantities of diphtheria toxin when injected intracutaneously. If antitoxin is absent or present only in very small amounts, insufficient for protection from diphtheria, a positive reaction will appear in from twenty-four to forty-eight hours.

The Positive Reaction.—A positive reaction is characterized by a circumscribed area of redness and slight skin infiltration which measures from 1 to 2 centimeters in diameter. It persists for five to fourteen days, and on fading, shows, as a rule, superficial scaling and a per-

sistent brownish pigmentation. The amount of toxin injected, as advised by Schick, is $\frac{1}{50}$ M. L. D. (minimum lethal dose) for the guinea-pig, in 0.1 c.c. of normal saline. We use $\frac{1}{50}$ M. L. D. in 0.2 c.c. There is one advantage in Schick's dilution in that it permits considerable deterioration of the toxin and still leaves it sufficiently strong to be effective. We are making comparative tests and may return to Schick's original dosage. It is desirable to give exactly 0.2 c.c. but even such variations as 0.1 c.c. and 0.3 c.c. give fairly consistent results —the area of redness being smaller when 0.1 c.c. is given and larger where 0.3 c.c. It is absolutely necessary to give it intracutaneously so that the toxin will remain in the dense tissue and have time to exert its irritant action. The slightly raised white area, at the point of injection, is infallible evidence of the delivery intracutaneously of the diluted toxin.

The Pseudoreaction.—Shick noticed that, in the older children and adults, a considerable percentage showed a protein reaction which had nothing to do with the specific toxicity of the toxin. In these cases, even when the mixture was overneutralized with antitoxin, this same pseudoreaction developed. In most cases, this reaction came on more promptly, covered a larger surface, was more of the urticarial type, had as a rule a more reddened central area and a lighter surrounding zone, and disappeared within two to four days. Pigmentation is absent or slight, and superficial scaling is very rare. In a small percentage however, the reaction persisted for a week or ten days and it was very difficult in many and impossible in some to decide between a true and pseudoreaction. When there was a combined reaction it was even harder to decide how much, if any, was due to the toxin and how much to the non-toxin protein, because the development of a true reaction in no way prevented the protein reaction.

Control Tests.—The best practice, therefore, in older children and adults is to inject the toxin in the skin of one arm, and the heated or antitoxin neutralized toxin in the other arm. In this way the amount of protein reaction can be noted, and it can be decided in the majority of cases whether the reaction following the toxin is a simple, true reaction, a pseudoreaction, or a combined reaction. Even after the eye has been thoroughly trained, it is still wise to use the two injections when possible. Any cases which remain in doubt are considered as true reactions and treated accordingly.

Details of the Technic.—I think it is apparent to all that the technic of the Schick reaction, although very simple, must be carried out with the greatest accuracy, or the results will be entirely misleading. If the toxin has been diluted and stored, in a warm place, *it may readily deteriorate* and, instead of giving 0.02 of a fatal dose (M. L. D.) only one-half that amount may be injected, and no toxic reaction will occur, and the misleading idea is given that the person has been shown to be immune. If the toxin is incorrectly diluted, and a large surplus of toxin is given, slight necrosis may develop at the point of injection.

Use of Diphtheria Toxin in Schick Test. Directions for Using the Capillary Outfit.—Break off one end of the capillary tube, push the broken end carefully through the neck of the rubber bulb until it punctures the diaphragm within and enters the cavity of the bulb; then break off the other end of the tube. Hold the bulb between thumb and middle finger, place the index finger over the opening in the end of the bulb and expel the toxin into 10 c.c. of saline (Fig. 12). Rinse out the capillary tube by drawing up saline several times, then cork the bottle and shake the diluted toxin. Inject exactly 0.2 c.c. representing $\frac{1}{50}$ M. L. D. for the guinea-pig, *intracutaneously* on the flexor surface of the forearm or arm. The contents of the bottle are sufficient for about 35 tests. On account of the fairly rapid deterioration, it is not advisable to use the diluted toxin after twelve to twenty-four hours. The outfit must be kept very cold to prevent deterioration.

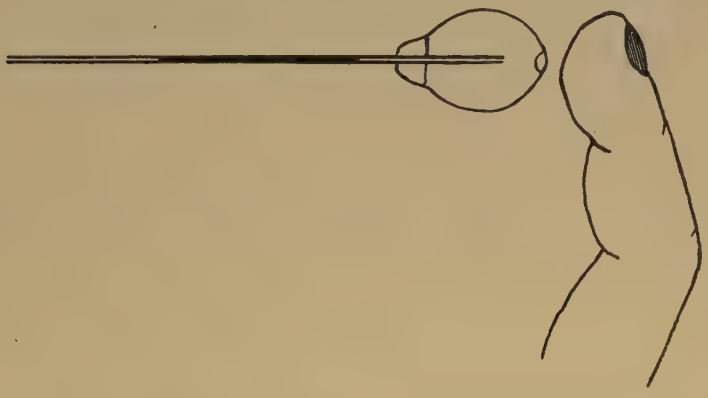

FIG. 12.—Method of using capillary tube and rubber bulb. Toxin in middle forced out.

A uniform technic in the intracutaneous injection is essential in the Schick test. A good guide for the insertion of the needle into the proper layer of the epidermis is to be able to see the oval opening of the needle through the superficial layers of cells. A definite, wheal-like elevation, with the distinct markings of the openings of the hair-follicles, shows that the injection has been made properly and that the fluid is confined to a small area of the epidermis. Here it will exert its irritant action, if the individual tested is not immune to diphtheria.

Syringes and needles: Preferably a 1 c.c. "Record" Tuberculin Syringe, and a fine platinum-iridium or steel needle. An ordinary hypodermic syringe with a fine steel needle may be used in emergencies.

On two occasions when the test was employed elsewhere in New York State the directions for diluting the toxin were not read, and some hundreds of people received undiluted toxin and developed very sore arms. The neutralized or heated toxin, used for the pseudoreaction, must also be prepared with care.

To carry out the test, it is essential to have an accurate syringe, with

a sharp, but short-pointed, fine needle. Most persons prefer a needle with a length of one-half inch. The usual 1 c.c. "Record" tuberculin syringe, with a fine platinum-iridium needle, answers the purpose well. The Research Laboratory places a standard diphtheria toxin in capillary tubes in such amount that the contents of one tube added to 10 c.c. of water gives the required dilution. The dilution will keep in the ice-box with little deterioration for at least one day. When bulk toxin alone is at hand, further dilutions are made in normal saline, of such strength that 0.1 or 0.2 c.c. contains $\frac{1}{50}$ M. L. D. for the guinea-pig. As already stated, Schick prefers a bulk dose of 0.1 c.c. while we prefer 0.2 c.c. This amount is injected, intracutaneously, on the flexor surface of the arm or forearm. The persistent pigmentation for several weeks which often results may make selection of the forearm in women slightly objectionable.

Interpretation of Reaction.—Though the intensity of the reaction varies in different individuals, a well marked persisting redness indicates an almost complete absence of antitoxin in the individual tested. Faint reactions lasting three to seven days point to the presence of very small amounts of antitoxin, which are not sufficient, however, to certainly protect the individual against diphtheria, but are sufficient to protect from systemic intoxication. To prevent the appearance of the reaction, according to Schick, the presence in an individual of at least $\frac{1}{30}$ unit of antitoxin per c.c. of blood is required With the toxin dilution we employ, $\frac{1}{50}$ unit will prevent a reaction. According to v. Behring, even as little as $\frac{1}{100}$ unit of antitoxin will protect against the disease in uncomplicated cases. In a child three years of age, weighing 35 pounds, we found that a subcutaneous injection of 10 units of antitoxin was sufficient to prevent the appearance of the Schick test when made twenty-four hours after the injection of antitoxin.

The Practical Value of the Schick Reaction.—The Schick reaction has been carried out by us, during the past five years, on all patients entering the scarlet fever pavilion of the Willard Parker Hospital. Only cases giving positive reactions were immunized against diphtheria; those giving a negative reaction received no immunization, but were carefully observed. Although many of the negatively reacting patients became carriers of virulent diphtheria bacilli during their stay in the wards, no cases of clinical diphtheria developed among them. The patients who gave positive reactions received, in practically all cases, injections of diphtheria antitoxin. Previously to adopting this practice all patients were given antitoxin because without doing so about 6 per cent. of the cases developed diphtheria.

The percentage of individuals susceptible to diphtheria is shown by the Schick test to be greatest between the ages of one and two years. It is less during the second six months of life, and less in older children, and least in adults and infants under six months. In adults living in New York City the positive reactions were not more than 20 per cent. In some institutions and in people from different races and localities higher percentages were obtained.

SUSCEPTIBILITY OF VARIOUS AGES TO DIPHTHERIA, AS INDICATED BY DIPHTHERIA-TOXIN SKIN TEST IN OVER 20,000 PERSONS.

Age.	Average susceptible. Per cent.	Range.	
		Schick.	Positive.
At birth	10	0	15
Under 4 months	15	0	15
4 to 6 months	30	20	30
6 to 9 "	60	60	74
9 to 1 year	75	65	75
1 to 2 years	75	60	76
2 to 3 "	65	50	70
3 to 5 "	40	15	50
5 to 10 "	30	8	40
10 to 20 "	25	5	40
Over 20 "	20	5	42

It is interesting to compare these figures with the mortality at different ages. (See page 100.)

During systematic testing of groups of children belonging to families, we have been impressed with the frequency with which all the children of the same family gave a similar reaction. If variations were found, the younger children, with the exception of the baby, always gave the positive reactions. If the youngest child had a negative reaction, all the older children were also negative. On the other hand, if the oldest child in a family gave a positive reaction, the younger children always showed positive reactions. In a very few persons the skin seems to be a little less sensitive to the toxin than the average person, so that an unusually small amount of antitoxin prevents a positive reaction.

Permanence of Negative Reaction in Persons Developing Natural Immunity.—The value of the Schick reaction as a practical guide in judging the immunity of persons depends on the duration of this condition. If natural immunity developed in children lasted only a few weeks or months, the value of the Schick test would be in the immediate emergency of an outbreak of diphtheria when sufficient time was available to make the test in order to inject antitoxin or separate from danger those who showed a positive reaction. If, however, a child or adult developing natural immunity holds that immunity for life, the knowledge that it gives a negative Schick reaction is of value, not only for the present, but for the rest of the individual's lifetime. For the past five years we have been testing and retesting thousands of children and hundreds of adults and keeping records. We found that, with few exceptions, those who gave a negative Schick test continued to show immunity during the year. From this and the fact of the age distribution of immune children in families in which the younger have a positive reaction and the older children and adults a negative reaction, it would seem that when once a child develops natural immunity this is a usually lifelong possession. It is true that we have found, during the five-year period mentioned an annual change in about 4 per cent. of the cases noted to have had a negative

Schick reaction, have shown a positive reaction. It is my belief that all of these supposed changes in reaction are not actual but are due to the reading of the reaction at different intervals of time after the toxin injection. More careful observations in the future will show whether this opinion is correct or not. Where the same observer made the tests, the changes from negative to positive reaction were not over 3 per cent. In tests of small groups of adults, while in most no change at all occurs, there is occasionally one showing as much as 10 per cent. of change from a negative to a positive reaction. Although the lapse of natural immunity is so infrequent it is wise to retest young children or older persons who have just been or expect to be in direct contact with diphtheria if more than three months has elapsed since the test. I know of one nurse who contracted a moderate diphtheria seven months after a negative Schick test. Six weeks after recovery the nurse showed a positive reaction.

A matter of much practical importance is whether a person with sufficient antitoxin to give a negative reaction has sufficient to prevent the development of diphtheria. We have been so in the habit of considering that a positive culture on Loeffler's blood serum indicated that the suspected case had diphtheria, that we have lost sight of the true fact, which is, that such a culture simply indicates that the case is a carrier. By tests we know that the bacilli found in many are absolutely non-virulent. It is also an undoubted fact that a person who is a carrier of virulent or non-virulent diphtheria bacilli may be afflicted with a septic tonsillitis, due to the streptococci or other micro-organisms. When a case of doubtful diphtheria has a negative Schick test and a positive culture, it is extremely difficult to decide how to consider the case. From the practical standpoint, antitoxin should be given if the case is at all serious because there is always a possibility that there has been some error in the technic of the test, or in its reading, or some mistake as to the identity of the individual. From the scientific viewpoint, the matter is of special interest. During the five years we have used the Schick test, no cases of severe diphtheria have developed in persons known to have had a recent negative Schick test, while some eight cases of moderate tonsillar infection with diphtheria bacilli have been observed in such individuals.

In all but two of these cases, no antitoxin was given, and recovery took place, as in similar cases of doubtful diagnosis in which no diphtheria bacilli were to be found in the cultures. In an adult who had given a negative Schick test eleven months previously a characteristic moderately severe case of diphtheria developed. This and the nurse mentioned above are the only undoubtedly true cases that I have personally encountered. It seems safe to rely on the belief that a person with a sufficient amount of antitoxin to give a negative Schick test is incapable of developing constitutional toxemia, or a severe infection from diphtheria bacilli. There is a doubt as to whether very slight infections of the superficial mucous membrane may occur in such persons. My own opinion is that the great majority of cases supposed

to be of this character are instances of streptococcus infection, the diphtheria bacilli being present as in a carrier. In a home for foundlings seven very young children living in one portion of the building developed tonsillitis with patches. Six of these had diphtheria bacilli; one had none. All recovered quickly. Two received no antitoxin. In other parts of the building there were many carriers but no tonsillitis. Those that show a faintly positive Schick test are liable to moderate local infections. Careful observations of these persons with faint reactions will allow us, in time, to decide whether they require immunization. If this is given, it should be produced by antitoxin for the immediate danger, and by toxin-antitoxin for later and permanent effect. It takes from five to six weeks to develop active immunity by the use of toxin-antitoxin. My own opinion is that except in the case of young children it is not advisable to inject these faintly positive cases.

The property of diphtheria toxin partially neutralized by antitoxin after injection in animals to produce antitoxin immunity became known to a number of investigators in 1895 and 1896 through attempting to use test animals that had recovered from the effect of slightly underneutralized test mixtures of antitoxin and toxin. Wernecke in 1895 reported that even fully neutralized toxins were effective for this purpose and that the young of these immune animals also possessed antitoxin immunity. In the following year I duplicated his results. Dreyer and Madsen in 1901 produced through similar injections in horses and goats serum of very considerable potency. The observations of Rehms on rabbits when added to those of other observers developed the fact that animals which have traces of antitoxin naturally respond in a few days to the stimulus of the neutral mixtures, while those which have none require four to six weeks. The guinea-pig and rabbit have no natural antitoxin while the horse and the goat usually possess it. In 1903 I began the use of toxin-antitoxin mixtures as a method of safely immunizing horses.

In 1905 Theobald Smith suggested in a publication that human beings might be immunized, but the time was not ripe. Experimental bleedings had demonstrated that two-thirds of infants beyond the age of nine months possessed no antitoxin, but there was no way to detect those that were susceptible except through bleedings and no method to determine the result of injections except by the same troublesome method. The introduction of the Schick test for antitoxin immunity by the intracutaneous injections of minute doses of toxin completely altered conditions. It became immediately practicable to test large numbers of people, so as to detect those having no antitoxin and to watch what changes if any follow toxin-antitoxin injections.

Behring and some of his associates were the first to attempt to immunize human beings with the neutralized toxin. His results were published in May, 1913. These while very incomplete were on the whole favorable. We began to use the human injections immediately after Behring's report. The most important problems to be worked

out were the exact degree of neutralization of toxin by antitoxin which would be most effective, the number and amount of the injections, the time of appearance, the extent and the duration of the immunity, the effect on the immunizing response to the vaccine of giving a simultaneous injection of antitoxin in another portion of the body, the reaction of the tissues in persons of different ages, the response in infants who are passively immune through the transfer to them of antitoxin from their mothers and finally the degree of local and constitutional protein reaction necessary.

The best degree of neutralization was tested out by trying different mixtures in guinea-pigs and horses. The following table gives the principal points of interest in one test.

The results of this and other experiments convinced us that a mixture that had sufficient antitoxin added to just rob the toxin of any poisonous effect even when given in large doses was as effective as one that was slightly toxic. Although in the amount that it is given a mixture which would be slightly toxic in large doses in a guinea-pig would probably be perfectly safe in an infant, it is nevertheless a great satisfaction to be able to use an effective non-toxic product. A useful point in the manufacture of the product is that a very slightly toxic mixture before filtration through a stone filter is just suitable for use after such treatment. As is clearly seen in the table it is not well to overneutralize, since the product becomes less and less stimulating of the production of antitoxin, as the excess of antitoxin increases.

ANTITOXIN PRODUCTION IN GUINEA-PIGS RECEIVING TOXIN-ANTITOXIN MIXTURES, HAVING DIFFERENT DEGREES OF NEUTRALIZATION.

To each unit of antitoxin was added toxin L+ dose.	Number of pigs.	Units of antitoxin in mixture.	L+ doses toxin in mixture.	Result as to life, died.	Toxin resistance of guinea-pigs at three months, m. l. d.
0.80	8	1	0.80	7	1.7
0.80	8	3	2.40	5	2.0
0.70	8	1	0.70	3	2.0
0.60	6	1	0.60	6	2.0
0.60	4	3	1.80	4	2.5
0.50	4	1	0.50	4	1.5
0.40	4	1	0.40	4	1.2

Immunity persisted almost unchanged for six months and was not much diminished at seven months. It was not evident after twelve months.

The size of the injection: This was tested in different animals and in man. It was found that moderate doses gave considerably better results than small doses. When the amounts given were greatly increased some additional response was noted, but not sufficient to make it wise to risk in man the objectionable protein reactions which develop in a certain proportion of persons injected. We finally decided on a 1 c.c. dose when it was possible to give three injections. The toxin used had a minimal fatal dose of about .0025, and an L+ dose about .40. A somewhat weaker or stronger toxin could equally well

be used if the amount of fluid was adjusted proportionately. The local reaction is due almost wholly to the autolyzed bacillus substance and other proteins in the culture fluid which are not related to the specific toxin. Attempts to remove these undesirable substances have already been partially successful. The number of injections: Each added injection gives an additional antitoxin response. For practical purposes it is necessary to restrict the number to as few as possible. This therefore has to be worked out by observations on human beings. Many hundreds of tests have demonstrated that from one injection we may expect at the end of three months about 70 per cent. of positive Schick persons to develop enough antitoxin to change to negative test. Two injections will change about 80 per cent. of the positive Schick cases and three about 90 per cent. If a second series of these injections are given to the refractory cases about 80 per cent. will respond. Even this remainder of 2 per cent. can be immunized by further injections. At the end of six months a somewhat larger percentage of negative cases will be found. Under different conditions one, two or three injections may be desirable. We try to give three when possible, but often have to be satisfied with two or even one.

RESULTS IN ACTIVE IMMUNIZATION AT SIX WEEKS AND THREE MONTHS.

No. of doses.	Amount, c.c.	Schick retest (six weeks).		Schick retest (2 to 3 months).	
		No. of cases.	Immune.	No. of cases.	Immune.
1 . . .	1.0	75	51 (68.0 per cent.)	239	175 (73.2 per cent.)
2 . . .	1.0	33	28 (84.8 per cent.)	89	80 (90.0 per cent.)
3 . . .	0.5	28	25 (89.3 per cent.)	28	26 (92.7 per cent.)
3 . . .	1.0	183	156 (85.2 per cent.)	201	191 (95.0 per cent.)

The time of the appearance of the antitoxin: A very interesting discovery was quickly made that warm-blooded animals which have traces of natural antitoxin produce very considerable amounts within five to seven days, while those which have none require from four to twelve weeks before appreciable amounts accumulate in the blood. The antitoxin content of the blood in immunized horses drops back to the original amount in about nine months. Some human beings have and some have no natural antitoxin, there are therefore among them those which respond quickly and those which respond slowly. The interesting fact developed that while those receiving injections which previously had antitoxin dropped as the horses in a year to their original amounts, those that had none continued to produce sufficient new antitoxin to give immunity.

The late development of antitoxin in those having a positive Schick test impresses the truth that toxin-antitoxin cannot take the place of injections of antitoxin when there is immediate danger of infection. Diphtheria antitoxin gives immediate and absolute immunity for a short period. Toxin antitoxin gives immunity after a lapse of from

one to three months and for a long period. Each therefore has its important part in the prevention of diphtheria and one supplements the other.

Bactericidal and antitoxic immunity: Immunity to diphtheria may be due to the presence of antitoxin or of bactericidal substances. The majority of those who recover from diphtheria have not developed at the time any appreciable antitoxin. We discovered this by resting convalescent cases that had recovered without antitoxin treatment. The immunity developed from the toxin antitoxin injections is almost wholly antitoxic. If sufficient antitoxin develops, it is as effective as a larger amount. Several investigators have measured the amount of antitoxin in a number of immunized cases. The following table gives some of Zingher's and Schroder's determinations:

Institution.	Number of injections.	Number immuned tested.	Age at time of injection.	Since injections, lapsed time, yrs.	Result.				Immunity, per cent.
					+	±	±	−	
1. Lying-in Hosp.[1]	2 and 3	167	3 days	1/100	146	..	..	21	13
2. Milk Station	3	350	2/12 to 4 yrs.	7/12	37	..	..	313	77
3. Leake & Watts	3	32	5 to 15 "	28/12	..	2	3	26	94
4. Hebrew Orphan.	1 and 2	68	5 to 15 "	28/12	3	2	4	59	93
5. House of Refuge	2 and 3	49	10 to 20 "	29/12	4	1	2	42	89
6. St. Dominic	2 and 3	38	4 to 12 "	32/12	2	..	3	33	95
7. St. Dominic	1	10	4 to 12 "	27/12	3	..	..	7	70
8. St. Joseph's	2 and 3	38	5 to 10 "	32/12	..	..	..	38	100

[1] The babies in the Lying-in Hospital were not Schick tested. Fully 90 per cent. would undoubtedly give a negative reaction. All others injected gave a positive Schick just before treatment. The average percentage of negative Schick tests at twelve months is about 25 per cent. The 13 per cent. in the injected cases is, therefore it indicates that at this early age the vaccine produced no results.

The Duration of the Immunity —This can only be determined after the lapse of years as the first to be immunized still possess antitoxin. No reports have been received from the persons receiving the first injections in Germany. Our observations, therefore, probably extend over the longest period of time. These are upon positive children in institutions which were immunized by Dr. Zingher from three to four years ago. He tested the results after one and two years. In his absence Dr. Schroder tested them last year. Each year some of the children leave the institutions and are lost track of so that the figures on the cases observed for three years or longer are rather small. Fortunately the results are so similar in the different groups that we can probably safely rely upon the moderate number of observations. It is remarkable how well the immunity persists. There has been almost no change from year to year. It appears as probable that the vaccine has not only stimulated a production of antitoxin, but has aroused the cells to an activity which had before remained dormant, so that these persons who before made no antitoxin join the larger group who normally produced it. There is so far as I know no explanation of the making of natural antitoxin. The fact that it develops in the children of most families at a certain age and that it is present in the great majority of horses and many other animals excludes the possibility

that it is generally due to the stimulus of diphtheria bacilli present in the throat without producing disease and therefore undetected.

The effect of giving in different portions of the body antitoxin and toxin-antitoxin simultaneously: The fact that in man and in animals the members that have antitoxin present in their bodies react to the T. A. injections is sufficient proof that antitoxin in the circulating fluids does not prevent injection of T. A. from stimulating additional antitoxin.

Horses as they accumulate antitoxin during immunization continue to receive stimulus from continued injections of toxin. It is true, however, that larger amounts are required to exert the necessary effect. The presence of antitoxin lessens therefore somewhat the effectiveness of the stimulus of an equal amount. We have not made sufficient observations on young infants to be certain of the degree to which the presence of antitoxin diminishes the response. That it has some effect is clear. Given after the toxin-antitoxin it has no inhibiting effect. Two institutions gave very interesting results. In one the antitoxin was given at the same time as the first injection. In the other simultaneously with the second. In the first the results were only half as good as usual while in the later case no inhibition was apparent.

The Reaction at Different Ages.—The baby of an immune mother is immune because of the passive transfer of antitoxin as well as other antibodies. Sometime during the first year it usually completely eliminates the mother's antitoxin. Later as a rule its own cells develop it. The infant may differ from an older child in another way. Besides having antitoxin from its mother, its cells may not yet have acquired the ability of producing antitoxins. Infancy is the time of life at which we would like to immunize because diphtheria is chiefly a disease of the early years of life. The problem to solve as to the earliest age that practical immunization can be carried out is therefore a very important one.

Last year we injected 2100 infants on the third, sixth and ninth days after birth. After a lapse of twelve months we retested many of them and discovered that they possessed the same average immunity as untreated infants. This age is therefore too young. We have immunized many non-immune infants of an age from six months to one year and have found them as readily immunized as the older children. The degree of local and constitutional reaction to the injections: Our observations have convinced us that the reactions are due chiefly at least to the proteins other than the toxin. Even if the toxin itself produces any local or constitutional disturbance it must be as a general protein and not as a specific toxin for the latter has been neutralized so as to possess no specific toxic power. The protein reaction is absent in the newly born, infrequent in the young child and more frequent in the older child and adult. There may be an indurated, reddened and painful area of several inches in extent. Except on one occasion when by accident a contaminated product was given abscesses have not occurred. On this occasion out of some two hundred children injected twelve

developed superficial localized abscesses. No permanent deleterious results have been met with. We are now trying a preparation made from the precipitated toxin-antitoxin. The protein reaction is much less. When perfected this refined product will probably be the only one used. The Department of Health and the Department of Education have united in a campaign to eradicate diphtheria. It may be of interest to include here a circular given to all the children in the primary classes of one hundred public schools in May of this year.

DEPARTMENT OF HEALTH. DEPARTMENT OF EDUCATION.

CITY OF NEW YORK.

Children who attend the schools are guarded as carefully as possible by school nurses and teachers from disease. Nevertheless, they come so closely in contact with each other, that they are likely to carry infectious diseases and to transmit them to one another.

Diphtheria attacks nearly 12,000 children every year, and causes the death of nearly 10 per cent. of these (or about 1200 children). We are now reasonably certain that we know how to protect your child against this disease, IF YOU WILL HELP.

By injecting one drop of a test liquid under the skin of the child, we can tell within two or three days whether your child is naturally protected against diphtheria, or whether it is readily capable of catching the disease. If the child is safe, nothing need be done. If it is not safe, we can make it so by three harmless injections given at intervals of a week. The child will then probably be protected for life. The test is simple, free from all danger, and will not make your child sick. This is a safe thing to apply no matter how young the child is. Diphtheria can be practically wiped out among children who receive this treatment.

If you want to protect your child and not blindly trust to luck, then don't wait. Let your family doctor apply the test at once and give you a certificate showing that your child has been tested, stating whether or not it is safe from diphtheria. If it is not safe, let your doctor at once give the three injections that will practically guarantee protection.

If you cannot obtain the services of a private physician, sign the slip attached below and a Health Department physician will apply the test and the remedy.

If you want the Health Department doctor to apply the test and the remedy, sign the following:

.....

CONSENT FOR SCHICK TEST AND IMMUNIZATION.

I hereby consent that.....of.....
(Name) (Address)
may receive from the Department of Health physician the test to determine if the child is liable to contract diphtheria. If found to be in danger of contracting this disease, I consent that the protective vaccination be given

Dated, New York.....19... .....
(Parent) (Guardian)

It is expected that these measures will be introduced into all the New York City schools next fall.

SEPTIC SORE-THROAT.

Streptococcic infection of the throat appears at times as a severe epidemic. Most of these epidemics have been traced to the milk supply.

Infectious Agent.—The infectious agent is the hemolytic type of streptococcus. The bovine streptococcus produces mastitis in cows, but does not cause septic sore-throat in man, unless a secondary infection of the udder by a human type of streptococcus takes place. In such cases the cow acts as a carrier of human streptococci, and the milk-borne outbreaks are usually prolonged.

Source of Infection.—The source of infection is the human nasopharynx, usually the tonsils; any case of acute streptococcic inflammation of these structures being a potential source of infection, including the period of convalescence of such cases. The udder of the cow infected by the milker is an occasional source of infection. In such cases the physical signs of mastitis are generally absent.

Mode of Transmission.—The mode of transmission is by direct or indirect human contact, or by consumption of raw milk from an infected udder.

Incubation Period.—The incubation period is one to three days.

Period of Communicability.—The period of communicability in man, is presumably during the continuance of the clinical symptoms; in the cow, during the continuance of discharge of the streptococci in the milk, the condition of the udder tending to a spontaneous subsidence. The carrier stage may follow convalescence and persist for some time.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the Disease* by the clinical symptoms, assisted by bacteriological examination of the lesions or discharges from the tonsils and nasopharynx.

2. *Isolation* of the patient during the clinical course of the disease and convalescence and particularly by the exclusion from participation in the production or handling of milk or milk products.

3. *Concurrent disinfection* of articles soiled with discharges from the nose and throat of the patient.

II. General Measures.—1. *Exclusion of the suspected milk* from public sale or use, until pasteurized. The exclusion of the milk of an infected cow or cows in small herds is possible when based on bacteriological examination of the milk of each cow, and preferably the milk from each quarter of the udder, at frequent intervals.

2. *Pasteurization of all milk.*

3. *Education* in the principles of personal hygiene and avoidance of the common towel, drinking and eating utensils.

SMALLPOX.

Smallpox (Variola).—An acute infectious disease characterized by an eruption of papules, vesicles and pustules, which upon healing

produce typical scars on the skin of varying depth and extent. It is highly contagious and controlled only by vaccination.

The exact nature of the exciting factor in smallpox is undetermined. Certain "vaccine bodies" found chiefly in the epithelial cells of the skin and mucous membranes in the specific lesions have been claimed to be protozoa causing the disease; but opinions still differ as to this.

The diseases smallpox, cowpox, horsepox, sheeppox, if not identical are closely allied. Experiments, indeed, have demonstrated that at least cowpox and smallpox are very nearly related, if not essentially the same disease. Several experimenters believe they have changed smallpox virus into cowpox. We have not been able to make this transformation. The virus used by the Department of Health has been transferred from cow to cow for at least thirty years and is believed to have come originally from cowpox.

Incidence.—Smallpox was for many centuries one of the greatest scourges of the human race. It was more common than measles and much more fatal. It is believed that in the 18th century every tenth death was due to smallpox. More than 500,000 are known to have died each year. Formerly smallpox was a children's disease, but since vaccination has protected the child, it has become somewhat more prevalent among adults who have received but one vaccination. No infectious disease shows a more complete independence of conditions, such as race, climate, soil, age, sex, occupation and sanitary surroundings, than does smallpox. It thrives wherever the infection is carried, and wherever it finds susceptible persons. Apparently no one is naturally immune. One attack ordinarily protects against another, but not necessarily; second and even third attacks are known. The disease occurs in epidemics of varying extent and severity, which often recur in waves. The reason for this is partly because of the number of unvaccinated persons who have had the disease and have been left immune. There seem to be also different strains of smallpox. In the same community the cases from a first focus will be on the average very light, while those from a second focus will be quite severe. The same is true of typhus fever. The endemic disease is of a much milder type than the imported.

Transmission.—Smallpox is probably transmitted by more or less direct contact, although the precise method of the conveyance of infection is unknown. The infection gains entrance into the system through the respiratory tract. The virus has been shown experimentally to be contained in the lesions of the skin and mucous membranes. The disease is infectious before the eruption appears, and for this reason it has been assumed to be present in the expired air; but this assumption has never been substantiated. Although the virus, as dried infected epithelium, is doubtless air-borne, the radius of infection is probably limited to the immediate neighborhood of the smallpox patient. There is no evidence to show that the infection is carried by the air to any distance or outside of the sick room. It is certainly not conveyed outside of the building occupied by the patient, as has sometimes been supposed.

Apart from more or less direct contact, smallpox infection may be spread by secretions from the mouth and nose. Fomites or objects which have become contaminated by the infective virus, such as eating utensils, towels, handkerchiefs, bed linen, and the like, may convey the infection; but the danger from this source is probably comparatively slight. Flies and other insects may act as mechanical carriers.

Prevention and Control.—The prevention and control of smallpox depend first upon vaccination, and second upon general sanitary measures, such as registration, isolation and disinfection.

Vaccination.—This consists in the transference of the living virus or active principle from the skin eruption of an animal having cowpox or *vaccinia* into the skin of a susceptible animal or man to prevent smallpox or *variola*. The disease thus produced (cowpox) is a modified form of smallpox. Cowpox is a mild infectious disease, characterized by a local eruption confined to the site of the vaccinated area, and accompanied usually by slight constitutional symptoms. When uncomplicated, death has never been known to be caused by cowpox. Jenner having had his interest aroused by the reports of farmers that an attack of cowpox gave immunity to smallpox made a thorough scientific investigation. In 1796 he transferred vaccine matter from the hand of a dairy maid to the arm of a boy. A typical take followed. He was inoculated six weeks later with smallpox virus. No take developed. Ten individuals who had cowpox, some one to fifty years before, were inoculated with smallpox without result. These tests established the value of cowpox vaccination. Gradually it supplanted the inoculation with smallpox virus.

Vaccine Virus.—Vaccine virus may be obtained from man, calves, rabbits and other animals. Human virus is now seldom used, chiefly because the supply would be inadequate, and also because of the possibility of conveying infection from diseases peculiar to man, such as syphilis. Bovine virus has always been more or less used since the time of Jenner, its discoverer, but since Copeman in 1891 showed that it could be purified with glycerin, it has come into general use.

Preparation of the Virus.—Vaccine virus may be used fresh, dry and glycerinated. The fresh virus, taken from the eruption of the calf or man and transferred directly, is still used to some extent in France. Dry virus is now not used at all. Glycerinated virus is the form at present preferably employed for vaccination. It consists of the vaccine pulp, or entire vesicle with its contents, treated with 50 per cent. pure glycerin. The addition of glycerin preserves the active principle of the virus and destroys the non-sporebearing bacteria, thus purifying it.

Fresh vaccine virus is said to be "green." When glycerin is added to the pulp and allowed to act upon it for a certain time, the virus is said to be "ripe." The addition of glycerin weakens the virus and finally destroys it. Vaccine virus should therefore not be used when green, nor when too old. *Seed virus* may be produced: (1) from glycerinated bovine virus which has been ripened for two or three months; (2) from rabbit virus, or the virus of rabbits vaccinated with stock bovine virus;

(3) from human virus, or lymph collected from the vesicles of previously unvaccinated children; (4) from glycerinated virus from calves which have been vaccinated with an emulsion of human vaccine crust; (5) from human-calf-rabbit virus, which in the Vaccine Laboratories of the New York City Department of Health has been found to be the most economical, efficient and reliable.

This human-calf-rabbit seed is produced as follows:

Crusts are collected from healthy children about nineteen days after vaccination. These are cut up and emulsified into a paste with boiled water. This humanized seed is then inoculated into a small area of a calf's abdomen. The pulp from this special area is separately collected and glycerinated. It is then tested bacteriologically and clinically. This bovine virus from human seed is now used (in a dilution of 1 part to $12\frac{1}{2}$ parts of normal salt solution) to vaccinate rabbits. Five days after vaccination the pulp is removed with a curette, weighed and emulsified with a solution of glycerin (50 per cent.), sterile water (49.5 per cent.), and carbolic acid (0.5 per cent.), in the proportion of 1 part of pulp to 8 parts of the solution. The regular supply of vaccine virus is produced by vaccinating calves (preferably females from two to four months old) with this rabbit seed.

The calves are vaccinated and the vaccine pulp collected under careful antiseptic conditions. The calves are inspected by a veterinarian at the time of purchase for such diseases as tuberculosis, glanders, foot-and-mouth disease, tetanus, skin diseases, etc. After the vaccine has been collected, the calves are immediately killed and their organs examined by the veterinarian. If at autopsy, an animal be found diseased, the vaccine is discarded. The calves are specially cared for in vaccine stables with concrete floors and stalls, which are kept flushed with water to wash away dejecta. They are fed on milk, no hay or straw being used for any purpose.

The vaccine pulp when collected is placed in sterile glass containers, packed in ice and shipped at once to the vaccine laboratory. As soon as received it is ground up and emulsified in the solution of glycerin, sterile water and carbolic acid as before described, and then tested for purity, for gas-forming organisms, for tetanus, and for streptococcus. After all the laboratory tests for purity have been made and found satisfactory, the vaccine is ready for use upon human beings, provided it be found to be efficient clinically. To determine this point inoculations of the vaccine are made upon previously unvaccinated children, all of whom must show a perfect take; and these clinical tests are made every two weeks as long as the vaccine is in use. If one test fail, the vaccine is called in.

Vaccine virus is put up in special containers, such as glass vials or capillary tubes, and on glycerinated points or strips of bone or other material dipped in the glycerinated virus. Packages of these are kept in an ice-box at a temperature of 33° to 40° F., ready for issue.

Methods of Vaccination.—Vaccination is to be considered as a surgical operation and performed accordingly. The inoculation may be made:

(1) by *puncture* with a needle moistened with the vaccine, which is the simplest method, but not always successful; (2) by *scarification* or cross-scratching with a vaccine point or needle dipped in the lymph, which has the objection of producing an abraded surface soon covered by a crust, through which the eruption penetrates with difficulty, and of causing possible infection under anaërobic conditions favorable to the development of tetanus; and (3) by *incisions*, which is the preferable method, and they are now commonly employed.

The incisions may be made with a sharp scalpel or knife, but better with a needle. They should not be so deep as to draw blood, although a few drops of blood do not matter. The circular issued by the State Department of Health is so excellent that it is given entire:

How Vaccination is to be Performed and Reported.—Chapter 133 of the Laws of 1915, which amended Sections 310 and 311 of the Public Health Law, specifies that no child or other person shall be admitted into *any* school in a *first* or *second-class* city unless it has been vaccinated. In third-class cities, towns and villages the vaccination of school children is compulsory only when the State Commissioner of Health has specified in writing to the school authorities in any municipality that smallpox exists in the school district or in the vicinity thereof.

The Law provides that vaccination shall be performed only by a regularly licensed physician, and in such manner as is prescribed by the State Commissioner of Health; that no vaccine virus shall be used unless produced under license issued by the Secretary of the Treasury of the United States and accompanied by a certificate of approval by the State Commissioner of Health. Every physician performing a vaccination shall also make a report to the State Commissioner of Health upon a form furnished by the Commissioner within ten days of the date of vaccination.

The vaccine virus shall be used within one year of the time it is issued for use and not later than the date (stamped upon each vaccine virus outfit) when the virus should be active.

Age at Which Vaccination should be Performed.—It is recommended that every infant should be vaccinated during the second six months of life and only when in good health; and that all persons be revaccinated whenever smallpox exists in any community. It is also recommended that vaccination be performed, insofar as is possible, between the months of October and June. The investigations of the accidents and complications which very rarely follow vaccination show that they are more likely to occur during the summer months and in children who are running about.

Cleanliness is absolutely essential. The site of vaccination and the physician's hands should be thoroughly cleansed with soap and water and allowed to dry. When the child is dirty it is recommended that it be given a full bath and dressed in clean clothing.

Instrument to be Used.—The only instrument to be used is a new needle with a sharp point sterilized by boiling or by heating in a flame or a scalpel or platinum scarifier sterilized in a similar manner. The

needle or vaccine point prepared by the manufacturer may also be used for this purpose for one vaccination if used immediately after taking it from its original package.

Technic of Vaccination.—Vaccination should be performed on the outer surface of the upper arm opposite the insertion of the deltoid muscle. The outer surface of the calf may be used, but it should be remembered that this site is more likely to be rubbed and is thus rendered more liable to infection. A small drop of vaccine is placed on the spot that has been cleansed and dried, and then with the new sterile needle, scalpel or platinum scarifier a scarification is made, not larger than the end of a match, or a single scratch not more than a quarter of an inch long, the scarification or scratch being made through the drop of virus. (*Cross-hatching or more than one scratch must not under any circumstances be employed.*) The vaccination should be allowed to dry thoroughly in the air. No dressing should be placed on the arm. In the event of a "take," a dressing of clean sterile gauze or clean cheesecloth may be fastened to the undergarment to protect the vaccination. The patient must be warned not to scratch or disturb it. No shield of any variety should be used. The scab should not be removed.

Dressing.—If the dressing becomes soiled by oozing from the vaccination the physician should remove the dressing and wash the area with a sterile salt solution or with cool, freshly boiled water. When the dressing is changed care should be observed not to touch the vaccination. A fresh sterile dressing on the inner side of the sleeve should protect the vaccination as before. In the usual course of vaccination dressings should be changed only a few times, but if there is a great deal of oozing they should be changed daily. *Never use shields.*

Normal Course of Vaccination.—If these directions are carried out a successful vaccination will take a normal course, which is as follows:

For three or four days there will be no sensation, except possibly a little itching. Then a small red area forms, in the center of which a spot like a blister appears, and there will be some tenderness and redness about the vaccination area. At this time there may be some slight soreness in the armpit and some feeling of illness. There is usually some oozing of yellowish material. The blister gradually dries up and a thick scab forms. The redness and tenderness gradually subside, and after two or more weeks the scab falls off, leaving a pitted scar. In a few cases the vaccination takes a somewhat severer course, causing more pain and discomfort than usual, and some fever.

Inspection and Report.—The vaccination should be inspected by the physician who performed the same between the fifth and ninth day after vaccination, and a report must be made on the form prescribed by the State Commissioner of Health.

These forms will be supplied by the local health officer and the vaccination report card should be returned to him.

Successful Vaccination.—Successful vaccination requires that the take be typical and the clinical cause characteristic.

The following are the average signs and symptoms of a typical primary vaccination when two incisions or cross-hatching is employed:

At the end of thirty-six to forty-eight hours there is seen at the point of inoculation a slight papular elevation, small, round, flat, bright red, hard, but superficial. This papule gradually increases in size and on the fifth or sixth day shows a definite vesicle. The vesicle is at first clear and pearl-like, the margins are slightly raised while the center is depressed or umbilicated. A deep, red swollen zone or areola surrounds the vesicle. By the seventh day the vesicle has attained its maximum size. It is round or oval, umbilicated, and contains a clear lymph. It is multilocular, *i. e.*, if opened, it will be found that only that portion of the lymph contained in the compartment opened will exude. By the eighth day it is yellowish, distended with lymph, and a second umbilication follows. The areola deepens and widens. The skin is hot and painful, and the neighboring glands become enlarged and tender. About the ninth or tenth day the areola begins to fade, and the swelling decreases. On the eleventh or twelfth day, the lymph becomes more opaque and commences to dry. At the end of the second week the vesicle is converted into a brownish scab which eventually separates and leaves a pitted scar characteristic of cowpox.

The constitutional symptoms following vaccination are more or less marked. Usually on the third or fourth day the temperature rises and may persist until the eighth or ninth day. In children the fever may be accompanied by restlessness and irritability; but as a rule the symptoms are trivial. If the vaccination is made on the arm, the axillary glands are enlarged and sore; if on the leg, the inguinal glands are affected.

Immunity.—The immunity appears about the eighth or ninth day. Its duration is very variable, differing in different individuals. The earliest case on record is one nine months after a successful vaccination. In some instances it is permanent, but a majority of persons when ten years have elapsed again become susceptible. It is extremely rare for a person who has been properly vaccinated to have severe smallpox, but it sometimes happens. Smallpox itself does not always protect against smallpox.

Revaccination.—The best time to make the primary vaccination is after six months and before the expiration of the first year. Revaccination should be performed between the tenth and twelfth year. After this it is, as a rule, unnecessary to vaccinate again, unless there is danger of exposure. All persons who have been exposed in any way to smallpox should be immediately vaccinated, excepting those who within one year have been successfully vaccinated. There are no contra-indications. Vaccination will almost always prevent the development of smallpox, if taken promptly after exposure.

Complications and Dangers.—These have been greatly exaggerated, but vaccination is by no means always harmless and uncomplicated. The vaccinia produced is usually a mild affection, but it is, nevertheless, an acute infectious disease, and should not be treated lightly. The

wound, like any other small abrasion or scratch, may become infected, unless proper precautions are taken to prevent it, although with the improved quality of the vaccine now used and modern aseptic methods of operation, a bad sore arm and serious complications are exceptional.

Among the more important complications are: *Auto-vaccination*, due to scratching of the virus with the fingers into the nose, mouth, mucous membranes, or skin, if introduced into the eye it may cause blindness; *generalized vaccinia*, produced by absorption of the virus, which is extremely rare; *wound infections*, such as ulcers, gangrene, erysipelas, abscess, suppuration of the axillary glands, and other septic infections, which now seldom occur. *Tetanus* may occasionally complicate vaccination, as it may any other wound. Its occurrence after vaccination is thought to be due to lack of care and neglect of the wound, and not to the vaccine itself. *Foot-and-mouth disease* has been known to occur as a contamination of vaccine virus. Although this infection is not transmissible from cattle to man through cutaneous inoculation, this contamination is now guarded against by the Federal law requiring vaccine virus to be tested in order to assure freedom from this as well as other infections.

Claims.—Vaccination is not claimed to be an invariable and permanent preventive of smallpox, but in an immense majority of cases successful vaccination renders the person for many years unsusceptible. The period of protection has not been accurately determined. It may endure for life, or only for a year or two. As a safe rule to follow, persons should be vaccinated every eight or ten years. While the individual protection is not always perfect, vaccination and revaccination systematically and generally carried out confer complete protection to communities and nations. Should a vaccinated person later contract smallpox, the disease is usually in a milder form than in unvaccinated persons, known as *varioloid*. Should an unvaccinated person contract smallpox, and vaccination be performed about the sixth or eighth day of the period of incubation, it takes and may modify the severity of the disease. If the vaccination is done at the beginning of the incubation period, or in time to have the vaccine eruption reach maturity before the smallpox begins, it will prevent or abort the disease.

Results.—Communities in which vaccination and revaccination are thoroughly carried out are those in which smallpox has the fewest victims. Since the enactment, in Germany, of the law requiring the compulsory vaccination and revaccination of all persons, in 1874, there have been no epidemics of smallpox in that country. The disease is frequently introduced by foreigners, particularly on the frontiers, but it can obtain no foothold. In 1897, there were but five deaths from smallpox in the entire German empire, with a population of fifty-four millions. The large German cities, Berlin, Hamburg, Breslau, Munich and Dresden, have a perfectly insignificant mortality from smallpox as compared with London, Paris, Vienna, and Petrograd, in all of which the vaccination laws are relatively lax. Among large

bodies of men (*e. g.*, the German army), in which vaccination and revaccination is regularly practiced, smallpox is unknown. These facts should convince anyone of the efficacy of vaccination as a preventive measure against smallpox.

Registration, Isolation and Disinfection.—While general sanitary measures are necessary for the control of smallpox, as of all infectious and communicable diseases, they cannot be relied upon for the prevention of this infection. They should not be regarded as substitutes for vaccination in smallpox.

Registration should include, as far as possible, all suspicious as well as definite cases of the disease. Chickenpox especially, on account of its close resemblance to smallpox, in the presence of an epidemic, should always be regarded as suspicious until a positive diagnosis is made.[1] In well defined cases of varicella the characteristic vesicles, the irregularity of their appearance, the short stage of invasion, the slight constitutional disturbance, and the greater intensity of the eruption on the trunk, should make the diagnosis clear.

Isolation and disinfection should be rigorously carried out for the reason that smallpox is one of the most contagious of the communicable diseases, and also because these measures may lessen the danger of infection, especially when there are few cases.

It is always best that the patient be taken at once to a special hospital, vacant house or tent. But this place of isolation need not be a desolate "pest-house." As there is practically no danger from the proximity of a smallpox hospital, it may be located in the vicinity of other habitations, provided, of course, the necessary precautions are observed to prevent the spread of the infection.

Isolation in a private house is possible, but it should be permitted only if the room, in which the patient is treated, is properly screened, well ventilated, and so equipped that it can be kept scrupulously clean. A trained nurse must be in attendance and all visiting strictly forbidden. The food must be prepared in a separate kitchen, and special care must be taken that all dishes, etc., used are scalded and all remnants of food burned. No objects, such as bedding, towels, underwear, etc., must be allowed to leave the sickroom unless they are first boiled, steamed, or soaked in a disinfecting solution of bichloride of mercury (1 to 1000) or formalin (10 per cent.). Carbolic acid should not be depended on. All articles which may have become particularly contaminated by the patient before or after isolation should be burned

[1] In the first stages of smallpox the eruption is hard and "shotty," it extends into the skin, while in chickenpox the vesicles are superficial and easily broken. In chickenpox the eruption comes out in successive crops, and there is very little eruption on the hands and feet. If some of the suspected virus (heated to 60° C. for 30 minutes) is inoculated into the skin of a successfully vaccinated individual, a typical "immediate reaction" occurs within a short time, if the disease is smallpox; if chickenpox, no reaction occurs. Histological examination of the pock, by inoculation of the contents of the vesicle upon the cornea of a rabbit, shows the vesicle of smallpox to be multilocular; in chickenpox, it is unilocular. The vesicles of smallpox on the cornea of the rabbit are distinct and contain the "vaccine bodies;" the lesions in chickenpox are indistinct and do not contain the "vaccine bodies."

or thoroughly disinfected; and if the patient is removed to the hospital or dies, the room occupied by him should receive a terminal disinfection by sulphur dioxide or formaldehyde gas. It should finally be thoroughly cleansed, aired and sunned.

The patient being the principal source of infection, all articles that have come in contact with his body, and particularly all dressings which may have become soiled with the contents of the vesicles, should be burned. The secretion from the mouth and nose, as also the other discharges from the body, urine and feces, must be disinfected with bichloride of mercury or chlorinated lime. Quarantine in a case of smallpox is usually observed until all desquamation ceases. This may be favored by the use of warm baths and the application of oil (camphorated oil or vaseline) to the skin. The hair, fingernails, and all folds and creases of the skin should receive a special cleaning before the patient is discharged.

CHICKENPOX.

Chickenpox (Varicella).—An acute infectious disease of children, characterized by an eruption of vesicles on the skin.

The disease occurs in epidemics, but sporadic cases are also met with. It may prevail at the same time as smallpox or may follow or precede epidemics of this disease. Although usually regarded as one of the minor communicable affections of childhood, it is by no means always a harmless disease. It may produce cicatrices; sepsis or erysipelas may result; and complications, such as pneumonia, nephritis and gangrene of the skin may also follow. One attack confers a definite immunity, as a rule. But an attack of chickenpox is no protection against smallpox. The disease usually runs a mild course occuring in children between the second and sixth year. It is rarely seen among adults. But because it may often be mistaken for smallpox, chickenpox should be a reportable disease.

Infectious Agent.—The infectious agent is unknown.

Source of Infection.—The source of infection is presumably in the lesions of the skin and of the mucous membranes; the latter appearing early and rupturing as soon as they appear, render the disease communicable early, that is, before the exanthema is in evidence.

Mode of Transmission.—The mode of transmission is directly from person to person, and indirectly through articles freshly soiled by the discharges from an infected individual.

Incubation Period.—The incubation period is from two to three weeks.

Period of Communicability.—The period of communicability is until the primary scabs have disappeared from the mucous membranes and the skin.

Methods of Control.—The Infected Individual and his Environment.—1. *Recognition of the Disease by the Clinical Symptoms.*—The differential diagnosis of this disease from smallpox is important, especially in people over fifteen years of age (see Smallpox). Monkeys cannot be vaccinated with virus from chickenpox, but can be from smallpox.

2. *Isolation.*—Exclusion of the patients from school and prevention of contact with non-immune persons.
3. *Concurrent disinfection* of articles soiled by discharges from lesions.
4. *Terminal Disinfection.*—Thorough cleaning.

MEASLES.

Measles (Rubeola).—An acute, highly infectious febrile disease, characterized by an initial coryza and a rapidly spreading skin eruption.

Incidence.—Measles is a disease of childhood, but unprotected adults are liable to the infection. Although in itself a comparatively mild affection, measles, on account of its complications (especially pneumonia) ranks as high as scarlet fever as a cause of death among infants and young children. The disease is practically endemic in all large centers of population and is apt to be especially prevalent every other year. In more sparsely settled places it from time to time spreads and prevails epidemically. It occurs at all seasons, but prevails more extensively during the colder months. One attack usually confers immunity; but second, third or even fourth attacks are known. The close resemblance between German measles (*rubella*) and measles (*rubeola*) probably accounts for many so-called second attacks.

Infectious Agent.—This is not positively known but is thought to be a filterable virus (found experimentally by Goldberger and Anderson in the blood of monkeys).

Source of Infection.—The virus of measles is contained in the buccal and nasal secretions of an infected individual.

Mode of Transmission.—The infection is chiefly transmitted directly from person to person; also sometimes indirectly through articles freshly soiled with the buccal discharges of an infected individual. Measles is the most easily transmitted of the communicable diseases. The "scales" or desquamating epithelium have been shown, as the result of experiments, not to carry the infection; and so far as is known, the disease is not air-borne.

Incubation Period.—This is long—from seven to eighteen days; usually about fourteen days.

Period of Communicability.—The period of communicability begins with the prodromal catarrhal symptoms of the disease and continues until the cessation of abnormal mucous membrane secretions, the minimum being seven days, or from two days before to five days after the appearance of the rash.

Methods of Control.—The control of measles is difficult, if not practically impossible, owing principally to two factors in the nature of the disease: (1) Because it is the most contagious of all the communicable infections; and (2) because it is most readily communicable in the prodromal or pre-eruptive stage, and before the disease is recognizable. The slight danger of the average case prevents heroic measures being taken.

But though comparatively little can be done to lessen the morbidity in measles, much can be done to decrease its mortality by delaying the age incidence until after the first five years of life, when the disease is most fatal, and by careful nursing and protection from the complication and sequelæ, more especially from pneumonia.

The methods of control are as follows:

I. The Infected Individual and his Environment.—1. *Recognition of the disease* as soon as possible by the clinical symptoms, special attention being given to any rise of temperature, the Koplik spots, and the catarrhal symptoms in exposed individuals.

2. *Isolation* during the period of communicability.

3. *Immunization.*—None.

4. *Quarantine.*—The exclusion of exposed susceptible children and teachers from school until eighteen days from the last possible exposure. This applies to exposure in the household, and exclusion of exposed susceptible children—those not having had measles—from all public gatherings for the same period.

5. *Concurrent disinfection* of all articles soiled with the secretions of the nose and throat.

6. *Terminal Disinfection.*—Thorough cleansing, airing and sunning of the room occupied by the patient. Terminal fumigation is of little or no value in preventing the spread of measles, as the virus does not live long on fomites. There is practically no danger of children contracting the infection from the room in which the patient was treated, provided fourteen days have elapsed. But formaldehyde fumigation and disinfection may be practised, if desired, especially if healthy children are soon to occupy the room.

II. General Measures.—1. Daily examination of exposed children and of other possibly exposed persons. This examination should include a record of the bodily temperature. A non-immune person exhibiting a rise of temperature of 0.5° C. or more should be promptly isolated pending diagnosis.

2. Where daily observation of the children by a doctor or nurse is available, the schools should not be closed or classes discontinued.

3. Education of the public as to the special danger of exposing young children to those exhibiting acute catarrhal symptoms of any kind.

GERMAN MEASLES.

German Measles (Rubella, Rötheln), or Epidemic Roseola.—This eruptive infectious disease has also been known as hybrid measles and hybrid scarlet fever, because it presents features common to both. It is now regarded as a separate and distinct affection.

Infectious Agent.—The infectious agent is unknown.

Source of Infection.—The source of infection is the secretion of the mouth and possibly of the nose.

Mode of Transmission.—The infection is propagated by direct contact with the patient or with articles freshly soiled with the discharges

from the throat or nose of the patient. It spreads with great rapidity, frequently attacking adults as well as children. The occurrence of either measles or scarlet fever in childhood is no protection against it. Epidemics of German measles are often very extensive.

Incubation Period.—From ten to twenty-one days.

Period of Communicability.—Presumably about eight days from the onset of the disease.

Methods of Control.—German measles is usually a mild affection, altogether less serious than measles. The reason for attempting its control is that German measles may be confused with measles or scarlet fever, especially during its early stages. Each person having symptoms of the disease should therefore be placed under the care of a physician, and the case should be reported to the local health department.

The measures of control to be instituted are as in measles.

SCARLET FEVER.

Scarlet Fever (Scarlatina).—An acute febrile, highly infectious disease, characterized by a diffuse punctate erythematous skin eruption, accompanied by catarrhal, croupous or gangrenous inflammation of the upper respiratory tract and by manifestations of general systematic infection.

Incidence.—The disease is very generally disseminated but is much more common in temperate climates than in the tropics. It occurs sporadically from time to time, and then under unknown conditions becomes widespread, the epidemics varying greatly in severity. Scarlet fever epidemics prevail at all seasons but perhaps with increased intensity in autumn and winter.

Among predisposing factors age is most important, a large number of fatal cases occuring before the tenth year. Adults, however, are by no means exempt. Very young infants are rarely attacked. As in other infectious diseases, a certain number exposed to the infection escape; this susceptibility to the disease varying in individuals even of the same family. Males and females are equally affected.

Infectious Agent.—This is unknown. By some the exciting factor is thought to be a streptococcus, but the evidence in favor of this view is very slight.

Source of Infection.—The belief at present is that the virus of scarlet fever is contained in the secretions of the nose and throat, in the blood and in the lymph nodes, and that it is given off in the discharges from the mouth, the nose, the ears, and from broken-down glands of infected persons.

Mode of Transmission.—The principal modes of transmission are: (1) Directly by personal contact with an infected person; (2) indirectly by articles freshly soiled with the discharges of an infected person. Carriers, and mild and unrecognized cases are doubtless frequent and play an important part in disseminating the disease. Foods may

also carry the infection. Milk-borne epidemics of scarlet fever have often been recorded. The "scaly" or desquamating epithelium, formerly thought to be infective, are no longer considered to convey the disease.

Immunity.—One attack of scarlet fever ordinarily protects against subsequent attacks, but this immunity is not always permanent; second and even third attacks have been reported.

Incubation Period.—Two to seven days; usually three or four days.

Period of Communicability.—This may be stated to be about four weeks from the onset of the disease if abnormal discharges have ceased, and all open sores have healed. Patients without discharge may therefore be safely relieved after this period, even if desquamation is incomplete. When discharges persist from the ears, nose or tonsils cases may be infected for eight to ten weeks.

Methods of Control.—Scarlet fever being a highly communicable disease, though somewhat less so than measles and smallpox, and often a very serious affection, the measures adopted for its control are necessarily in excess of the actual requirements.

I. The Infected Individual and His Environment.—1. *Recognition of the disease* by the clinical symptoms.

2. *Isolation.*—Whether in the home or hospital strict isolation should be maintained in each case until the period of infectivity is passed, that is for a minimum period of four weeks, most cases require five weeks. The patient may be treated at home, provided suitable conditions, such as a room for isolation and a trained attendant, are obtainable; but preferably the patient should be sent to an isolation hospital.

3. *Immunization.*—None.

4. *Quarantine* in this disease requires the exclusion of all exposed susceptible children and teachers from school and food handlers from their work, until five days have elapsed since the last possible exposure to a recognized case. This includes all persons exposed, unless immunized by a previous attack of the disease. Other members of a household, except food handlers, if the patient has been properly isolated, may be allowed to pursue their usual occupations.

5. *Concurrent disinfection* of all articles which have been in contact with a patient, and all articles soiled with discharges of the patient. This includes thorough disinfection or boiling of bed and body linen, dishes, etc., used by the patient, and destruction by burning of all clothes contaminated by discharges, remnants of food, etc. The attending physician should wear a gown and disinfect his hands, and other exposed parts, thoroughly after each visit. The nurse should take the same precautions as in smallpox or any other highly infectious disease. Thermometers and other instruments used should receive special care and disinfection.

6. *Terminal Disinfection.*—Thorough cleansing of all surfaces with good airing and sunning is sufficient; but formaldehyde fumigation may be practised if desired, and if the room is to be soon occupied.

II. General Measures.—1. Daily examination of exposed children and other possibly exposed persons for a week after the last exposure.

2. Where daily observation of the children by a doctor or nurse is available, the schools should not be closed.

3. Education of the public as to the special danger of exposing young children to those exhibiting acute catarrhal symptoms of any kind.

4. Pasteurization of the milk supply to guard against milk-borne scarlet fever.

WHOOPING-COUGH.

The infectious agent is the Bacillus pertussis of Bordet and Gengou. It is most abundant in the first days of the attack. After two weeks the bacilli are rarely obtained in cultures. They probably persist in some for considerably longer periods. The influenza bacilli are present in practically every case and add their influence.

This disease occurs in epidemics, but sporadic cases appear in a community from time to time. Epidemics prevail for two or three months, usually during the winter and spring, often preceding or following measles. Children between the first and second dentition are commonly affected. Adults and old people are sometimes attacked, and in the aged it may be a very serious affection. Whooping-cough is a dangerous disease because of the complications and sequelæ. Of these the most important are the pulmonary complications, such as bronchopneumonia, pneumothorax and tuberculosis. The very young infant is immune usually because of the transfer of passive immunity from the mother; but what was thought to be whooping-cough was probably distemper. One attack confers a definite and prolonged immunity but this disappears entirely in some after the lapse of years. Domestic animals (dogs and cats) may possibly be affected by whooping-cough, and transmit the disease.

Source of Infection.—The source of infection is the discharges from the laryngeal and bronchial mucous membranes of infected persons (sometimes also of infected dogs and cats).

Mode of Transmission.—The mode of transmission is by contact with an infected person or animal or with articles freshly soiled with the respiratory discharges of such person.

Incubation Period.—The incubation period is within fourteen days.

Period of Communicability.—The disease is particularly communicable in the early catarrhal stages before the characteristic whoop makes the clinical diagnosis possible. Communicability probably persists in other than carrier cases not longer than two weeks after the development of the characteristic whoop.

Methods of Control.—I. The Infected Individual and His Environment.—1. *Recognition of the disease* from the clinical symptoms supported by a differential leukocyte count, and confirmed when possible by a competent bacteriological examination of the bronchial secretions.

2. *Isolation.*—Separation of the patients from susceptible children and exclusion of the patient from schools and public places for the period of presumed infectivity.

3. *Immunization.*—The use of prophylactic vaccines gives a moderate proportion of the treated protection. This does not develop till after ten days to three weeks.

4. *Quarantine.*—Limited to the exclusion of non-immune children from school and public places for fourteen days after their last exposure to a recognized case.

5. *Concurrent disinfection* of discharges from the nose and throat of the patients and articles soiled therewith.

6. *Terminal Disinfection.*—Cleansing of the premises used by the patients.

II. General Measures.—Education of the public in habits of personal cleanliness and in the dangers of association or contact with those showing catarrhal symptoms with cough.

MUMPS.

Mumps (Epidemic Parotitis).—An infectious disease, characterized by inflammation of the parotid gland.

Mumps is probably endemic in large centers of population, occuring particularly in the spring and winter months. It is met with most commonly in childhood and adolescents. Very young infants and adults are rarely attacked. Males are somewhat more frequently affected than females in epidemics. The testes in males and the ovaries and breasts in females are sometimes involved, occasionally resulting in sterility. One attack usually confers immunity.

Infectious Agent.—The infectious agent is unknown.

Source of Infection.—The source of infection is the secretions of the mouth and possibly of the nose.

Mode of Transmission.—The mode of transmission is by direct contact with an infected person or with articles freshly soiled with the discharges from the throat and nose of such infected persons.

Incubation Period.—The incubation period is from four to twenty-five days; the average period is about fourteen days.

Period of Communicability.—The period of communicability is unknown but presumably until the parotid gland has returned to its normal size.

Methods of Control.—I. The Infected Individual and His Environment.—1. *Recognition of the disease* by its clinical symptoms. The inflammation of Steno's duct may be of assistance in recognizing the early stage of the disease. The diagnosis is usually made in the swelling of the parotid gland.

2. *Isolation.*—Separation of the patients from non-immune children and the exclusion of such patient from school and public places for the period of presumed communicability.

3. *Immunization.*—None.

4. *Quarantine.*—Limited to exclusion of non-immune children from school and public gatherings for fourteen days after the last exposure to a recognized case.

5. *Concurrent disinfection* of all articles soiled with the discharges from the throat and nose of the patients.

6. *Terminal Disinfection.*—None.

II. General Measures.—None.

TYPHOID FEVER.

Infective Agent.—The infective agent is the *Bacillus typhosus* or typhoid bacillus, which is constantly present in the pathological lesions of the disease. It probably always enters the body by way of the mouth, passes to the intestinal tract, penetrates the mucous membranes, and then invades the system. The bacillus leaves the body chiefly in the alvine discharges less often in the urine, and occasionally in other discharges. Healthy carriers of the infective agent are common.

Incidence.—The disease is most prevalent in the late summer and autumn months; but serious outbreaks may occur at any season of the year. It occurs both in endemic and epidemic forms. Endemic typhoid, or that which is constantly present, is sometimes spoken of as *residual typhoid*, a term applied to the unexplained typhoid fever which is still remaining in a community after the water supply has been purified, and in which all known sources of the disease have been eliminated. The disease is more prevalent in country districts than in cities, particularly in the southern States, probably owing to insanitary rural conditions.

Typhoid fever attacks individuals, as a rule, in the period of their greatest usefulness and value, that is between the ages of fifteen and thirty, thereby causing an enormous economic loss. It is not infrequent in childhood, but cases over sixty years of age are rare. As in other infectious diseases, not every one exposed to the infection is equally susceptible. It is now known that the bacilli do not multiply in water. Many survive only a few hours and a minute percentage remain alive in water more than seven days. In water that is polluted while more apt to be present, they disappear more rapidly, and more rapidly in the warm water of summer than in the cold water of winter.

Water-borne epidemics are recognized to have certain characteristics as follows:

1. They occur somewhat more frequently in spring, fall or winter, when the water is cold and freshets are apt to wash infection from its sources and convey it rapidly to the consumer.

2. They usually have a sudden onset, the number of cases rising to a peak and then declining rapidly.

3 The pollution is usually nearby, indicating the direct transmission of fresh, virulent infection.

Ice, exceptionally, may transmit typhoid bacilli. The total number of instances, however, of typhoid fever which have been directly

traced to ice infection are exceedingly few. Freezing itself does not kill more than 50 per cent. of typhoid bacilli, but in freezing many are eliminated and those that remain rather quickly die. This fact makes it possible to conceive that ice from moderately infected water may contain a few living typhoid bacilli, but these are so few in number that only the exceptional person here and there becomes infected, and thus the source of the infection remains undetected. Although freezing does not kill all the bacilli, there is a great reduction in their number not only from the act of freezing, but also during storage. The danger from the use of ice produced from polluted water is, therefore, much less than from the use of the water itself. Every week that the ice is stored this danger becomes less, so that at the end of four weeks it has becomes as much purified from typhoid bacilli as if subjected to sand filtration. At the end of four months the danger becomes almost negligible, and at the end of six months quite so. These facts assure us that natural ice which is stored usually for several weeks or months before it is used, is practically safe. There is no appreciable increase in the amount of typhoid fever in New York City in the spring when the new crop of Hudson River ice is used. The water from which the ice is taken is moderately infected. Manufactured ice made from distilled water and carefully handled is absolutely pure.

Milk is frequently a serious source of infection. The typhoid bacillus grows well in milk. Many epidemics of typhoid fever have until recently puzzled sanitarians because, though evidently milk-borne, yet no case of typhoid fever could be found. The discovery that about 2 per cent. of those who have recovered from typhoid fever remain infected, and continue for varying periods and even during the rest of their lives to pass typhoid bacilli, has cleared up the mystery. Persons who have never had typhoid fever may occasionally become carriers. Over four hundred cases of the disease were traced several years ago in New York City to the infection of a milk supply by a typhoid carrier who had the disease forty-seven years before. In a four years' study of typhoid fever in Washington, it was found that at least 10 per cent. of the cases were apparently milk-borne.

Hands, water, flies, etc., may all aid in the transfer of the bacilli from the infected dejecta to the milk. The milk may become contaminated on the farm, in transportation, at the city dairy or at the home.

Milk-borne epidemics have the following characteristics:

1. They curve abruptly, rise to a peak and subside rather sharply like water-borne epidemics, but they occur at any time of the year.
2. The cases occur on the track of a milk supply, and are mostly confined to that area.
3. The cases are found chiefly among those who are large consumers of milk.
4. More than one case is apt to occur at the same time in a family.
5. The disease shows a shorter incubation period, probably due to the greater amount of infection taken.

Unpasteurized milk products, such as cream, ice-cream, butter and buttermilk, and fresh cheese, may contain typhoid bacilli, and thus occasionally become a means of transmitting the infection.

In the same way other food products may become infected.

Raw oysters, clams, mussels and other shell fish grown in polluted waters, or any food contaminated by infected hands, flies, etc., may be an occasional mode of transmitting the disease. Several small epidemics, both in this country and in Europe, have been traced to eating raw oysters and other shell fish.

Fruits and Vegetables.—Such vegetables as celery, lettuce, radishes and watercress, which are taken raw and grown on land fertilized with fresh night soil, may become a means of transmitting the disease at times. Fruit and vegetables handled by a typhoid carrier may also become contaminated. Epidemics have been traced to these sources.

Flies.—The common house-fly and other insects, acting as mechanical carriers of the bacilli, may undoubtedly convey the infection from exposed typhoid discharges to food and the surfaces of things upon which they light. The danger from this source is now well recognized, though it has been probably exaggerated. Nevertheless, this danger is sufficient everywhere and especially among unsanitary surroundings to necessitate the proper screening and protection from flies, and the extermination of these and other insects as far as possible, by destruction of their breeding places.

Fomites.—Any objects which may have become soiled and contaminated by contact with the discharges of a typhoid patient, such as bed linens, blankets, and the like, may convey the infection.

Dust.—In dust the bacilli soon die, especially when exposed to the sun and air. Dust-borne infection in this disease, though conceivably possible, must be very exceptional.

Soil.—Formerly the soil was thought to be a most important factor in the production of the disease, and by Pettenkofer and others it was regarded as essential. But we now know that the condition of the soil does not affect the disease, other than that its pollution may endanger the contamination of drinking water, milk and other foods, or become a means of infection through flies, etc. In this respect the condition of the soil is of the greatest importance.

Typhoid Carriers.—Another important mode of transmission of infection in this disease, which is comparatively common, is by means of so-called typhoid carriers. Examinations of convalescent typhoid cases show that about 1 per cent. continue to pass typhoid bacilli for years, perhaps for life. Some of these bacilli carriers do not know either that they had typhoid fever or were in contact with it. In Washington typhoid bacilli were isolated from the stools of a number of healthy persons (0.3 per cent. of the number examined) with no known exposure. These not only had not had typhoid fever but had not been in contact with those having it.

These cases may be called "healthy or normal carriers" in contradistinction to "convalescent carriers," or those who harbor the bacilli

during convalescence only. In our laboratory we have found in a State institution for the insane six carriers in one hundred and forty convalescents, or about 4 per cent. The focus of infection is either the gall-bladder or gall-ducts. The majority of cases are women.

A remarkable case of a healthy carrier has been under our care for many years. Though well known from its publication in other places, it is of sufficient interest to repeat again here.

This was the case of a cook, who in 1901 was employed in a family, where ten days after entering the household a visitor developed typhoid fever. The cook had then been with the family three years, so at that time there was no reason to suspect the cook. She took a place in another family, and one month later the laundress in this family contracted typhoid fever. In 1902 the cook obtained a new position. Two weeks after her arrival, the laundress here was taken ill; in a week a second case developed, and soon seven members of the household were sick. In 1904 the cook went to a home in Long Island. There were four in the family as well as seven servants. Within three weeks after her arrival, four servants were attacked. In 1906 the cook went to another family. Between August 27 and September 3, six out of its eleven inmates were attacked with typhoid fever. Then for the first time suspicion was directed to the cook. She entered another family on September 21. On October 5, the laundress developed typhoid fever, and two months after her arrival 2 cases developed, one of which proved fatal. Altogether during five years this cook is known to have been the cause of 26 cases of typhoid fever.

On March 19, 1907, the cook was removed to the hospital. Cultures were taken every few days and showed bacilli off and on for three years. Sometimes the stools contained enormous numbers of typhoid bacilli, and again for days none would be found. After a detention of three years she was discharged after having promised not to cook. Two years later she broke the promise. Typhoid fever developed in two families and thus having become a cook in New York Hospital she was the cause of an outbreak in which some thirty-one doctors and nurses were attacked. This brought about her detection and second isolation at Riverside Hospital.

As already mentioned, we recently traced some hundreds of cases of typhoid fever to a milk supply produced at a farm looked after by a typhoid carrier who had typhoid fever forty-seven years previously.

The menace of these healthy carriers, especially in handling foodstuffs as in the case of a cook or waitress or in a dairy, in the transmission of typhoid fever, is self-evident. So far most of the outbreaks of the disease that have been traced have been due to carriers who discharge the bacilli in their feces rather than in their urine.

Diagnosis.—The diagnosis of typhoid fever is made by recognition of the clinical symptoms, the specific agglutination test and the bacteriological examination of the blood, bowel discharges or urine. Early diagnosis is important not only for the successful treatment of the disease, but for the control of the spread of the infection. This can only

be assured through laboratory methods which should be entrusted not to casual examiners but to experts. (For description of these methods, see "Pathogenic Microörganisms" by Park and Williams.)

The Gruber-Widal or Agglutination Test has been used for the routine examination of the blood-serum of suspected cases of typhoid fever since 1896, and proved to be of great assistance in the diagnosis of obscure cases of the disease.

Dried blood is ordinarily used for the application of the test.

Serum can be more accurately diluted and measured for the test than the dried blood, and for scientific investigations and for accurate results, especially in obscure cases and in those who have had the vaccine, when repeated tests may be required, it is to be preferred. Practically, however, the results are nearly as good for diagnostic purposes from the dried blood as from the serum, and the dried blood is more easily obtained and shipped.

It has been found that about 20 per cent. give positive results in the first week, about 60 per cent. in the second week, about 80 per cent. in the third week, and about 90 per cent. in the fourth week. In 98 per cent. of the cases in which repeated examinations were made, a reaction was present at some time during the illness.

Bacteriological Examination of the Blood.—This is the best method for early diagnosis, a blood culture being usually positive during the first week of typhoid fever. The bacilli may appear in the blood even in the first few days. They then lessen proportionately until the end of the disease. In relapses they reappear.

Examination of Feces and Urine.—The feces are collected in rectal tubes or glass vials. The more promptly the stools are examined after passage, the better is the chance of isolating the typhoid bacilli. Indeed, unless the specimen is sent to the laboratory immediately, it is practically useless to make the examination.

Typhoid bacilli are found in the feces upon examination often as early as the sixth or seventh day, and from then on until convalescence. In about 25 per cent. of all cases they may be obtained in the first examination, from the seventh to the twenty-first day of the disease, and in about 75 per cent. after repeated examinations. The short life of the typhoid bacillus in many specimens of feces suggests that stools should be examined as quickly as possible after passage.

Of great interest also is the frequent occurrence of typhoid bacilli in large numbers in the urine. They are not apt to be found in the urine until the end of the second week of the fever, and may not appear until much later. From this on to convalescence they appear in from 25 to 50 per cent. of all cases, usually in pure culture and in enormous numbers. They are found until several weeks or months after convalescence; in exceptional cases they may be present for years.

When we think of the chances such cases have to spread infection as they pass from place to place, we begin to realize how epidemics can start without apparent cause. The disinfection of the feces and urine should, therefore, be specially looked after in typhoid fever, and con-

valescents should not be allowed to go to places where contamination of the water supply is possible, without at least warning them of the necessity of great care in disinfecting their own feces and urine for some weeks.

Incubation Period.—The incubation period in typhoid fever is from seven to twenty-three days; average ten to fourteen days.

Period of Communicability.—This begins with the appearance of the prodromal symptoms of the disease, and continues throughout the illness and relapses, during convalescence, and does not cease until repeated examinations of the discharges show persistent absence of the infecting organism.

Immunity.—After recovery from typhoid a considerable natural immunity is present which lasts for years. This is not absolute, as about 2 per cent. of those having typhoid fever have a second attack which is usually a mild one.

Preventive Immunization or Vaccination.—An active immunity to typhoid fever may be artificially induced by injecting killed typhoid bacilli into the subcutaneous tissues. This so-called "vaccination" against typhoid fever is now a procedure of established worth—rational, harmless and effective.

Its use began in 1896 with Pfeiffer and Kolle and Wright independently. Wright then introduced the method in the English army, and the results led to its adoption in other countries. Vaccination against typhoid fever was started in the American army in 1899 under the supervision of Russell.

Three doses of the vaccine are usually administered when salt solution suspensions are used, the site of the inoculation being the subcutaneous tissues over the insertion of the deltoid. The first dose is 500,000,000, the second and third doses 1,000,000,000 each, typhoid bacilli. The period between the inoculations is seven to ten days, the injection being given late in the afternoon, so that if a reaction occurs the person will be in bed. The reaction usually consists of a reddening and swelling at the point of inoculation, which is tender. In some instances this area is larger, and the axillary lymph nodes become swollen and sore. A general reaction is usually absent, or if present consists of slight malaise. In a few cases, less than 1 per cent., a more marked reaction occurs with prostration and considerable rise of temperature. The reaction is of no importance farther than the discomfort caused.

The vaccine usually employed is a suspension of the bacilli grown on agar, standardized by the method of Wright and killed by heating to 56° C. Sensitized vaccines of either killed or live bacilli have also been used, but they have not been generally adopted.

During the war the army has used a suspension in cottonseed-oil. The three full doses are given in one injection. The oil prevents the rapid absorption and to some degree interferes with the immunity response.

The immunity produced varies both in degree and in duration. The

protection conferred is only relative, and with an undue amount of exposure infection may result. The duration of the immunity is at least one year, but it may last three or four years; the average being about two and a half years.

The results of typhoid inoculations can no longer be questioned. The most striking effects have been the reduction of the death-rate in those persons who have been properly vaccinated against the disease. The best results have been obtained in the armies of Europe and the United States. The French army was only about one-third vaccinated when war broke out. In consequence typhoid and paratyphoid fevers were abundant to such an extent that hundreds of cases developed daily. Within a year all were inoculated with the typhoid vaccine and the cases of fever diminished 90 per cent. Within the next year all had received paratyphoid A. and B. inoculations and the fevers diminished to 1 per cent. of the original amount. In the American army cases of typhoid fever were very few during the first year, but fairly frequent in the last half year of the war. Thus in July, 1918, a replacement unit consisting of 248 men going from Texas to England developed a number of cases, so that in all 39 per cent. were attacked with a mortality of 8.4 per cent. These men drank badly contaminated water. During the Château-Thierry offensive diarrheal diseases were very prevalent, approximately 75 per cent. were attacked. The prevailing diseases were simple diarrhea, bacillary dysentery, typhoid fever and the A and B types of paratyphoid fever. These conditions were met with at other portions of the front. It is evident that typhoid vaccine, although it gives a marked degree of immunity, cannot be wholly depended on when great exposure to infection is combined with great bodily strain. The inoculation being accompanied by no danger, the method is especially applicable to those unduly exposed to infection from typhoid fever, such as nurses, hospital attendants, physicians, travellers, soldiers in camps, persons in epidemic localities, and persons in the family of a bacillus carrier.

Methods of Control.—These may be divided into measures affecting the infected individual and his immediate environment; and general measures.

I. The Infected Individual and his Environment.—1. Success in the control as well as the treatment of typhoid fever depends upon early recognition of the disease by its clinical symptoms, confirmed by specific tests, the Widal or agglutination reaction and bacteriological examination of the blood, feces or urine.

2. *Isolation* in a fly-proof room, preferably under hospital conditions, of such cases as cannot command adequate sanitary environment and nursing care in their homes.

3. *Immunization* or preventive inoculation of all susceptibles who are known to have been exposed, or are suspected of having been exposed to the infection. This immunization is only relative and in no way does away with the need of precautions to prevent infection through water, milk, hands, etc.

4. *Quarantine.*—None.

5. *Concurrent Disinfection.*—The disinfection of all bowel and urinary discharges and articles soiled with them. For the urine bichloride of mercury (1 to 1000) or carbolic acid (2.5 per cent.) or formalin (10 per cent.) may be used and allowed to stand one hour. For the stools bleaching powder (3 per cent.), unslaked lime and hot water, carbolic acid (5 per cent.), or formalin (10 per cent.) are efficient. The disinfectants must be added in sufficient quantity and be left long enough in contact with the feces to thoroughly penetrate them. To disintegrate the feces, it may be necessary to break them up by stirring. The stronger disinfectants should be allowed to stand for at least one hour; carbolic acid requires twelve hours or more. The sputum and other discharges may be burned or scalded. Strong carbolic acid, cresol or formalin may also be used.

The patient should use his own special eating utensils, which should be scalded after use. All remnants of food should be burned or boiled before discarding. Attendants and nurses should be careful not only to avoid infecting themselves by constant washing of the hands in bichloride solution, but they should prevent the infection of others by keeping out of the kitchen, ice-box, etc., in private homes, unless there is a special diet kitchen for the patient.

Bedding, sheets, night wear, and all fabrics that may have come in contact with the patient or his discharges should be disinfected by boiling or immersion for one hour in bichloride of mercury solution (1 to 1000), carbolic acid (2.5 per cent.) or cresol. Thermometers should be kept in formalin, alcohol or other germicidal solution. Bedpans, which should be of glass or earthenware, must always contain some liquid disinfectant.

6. *Terminal Disinfection.*—At the conclusion of the cases a general disinfection and cleansing of the room and its contents should be carried out.

II. General Measures.—These may be summarized as follows:

1. Purification of public water supplies.
2. Pasteurization of public milk supplies.
3. Supervision of other food supplies, and of food handlers.
4. Prevention of fly-breeding.
5. Sanitary disposal of human excreta.
6. Extension of immunization by vaccination as far as practicable.
7. Supervision of typhoid carriers and their exclusion from the handling of foods.
8. Systematic examination of fecal specimens from those who have been in contact with recognized cases to detect carriers.
9. Exclusion of suspected milk supplies pending discovery of the person or other cause of contamination of the milk.
10. Exclusion of water supply, if contaminated until adequately treated with hypochlorite or other efficient disinfectant, or unless all water used for toilet, cooking and drinking purposes, is boiled before use.

If these measures, personal and general, for the control of typhoid

fever were consistently and conscientiously carried out, which depends to a large extent upon the coöperation and encouragement of local health officers, the prevalence of this disease in the United States, where it exists to an unwarrantable degree, would undoubtedly be greatly reduced.

PARATYPHOID FEVER.

Paratyphoid fever is clinically and etiologically similar to typhoid fever, from which disease it is often indistinguishable except by careful bacteriological examination.

Epidemiologically the two diseases are very similar. Paratyphoid is a world-wide infection, but it prevails less commonly than typhoid and though outbreaks occur of considerable extent, it never causes such fatal epidemics of the disease, as are often observed in water-borne or milk-borne typhoid.

Although the symptoms of the two diseases are somewhat similar, paratyphoid fever usually runs a milder course. The degree of immunity conferred by an attack of paratyphoid is probably marked; an attack of paratyphoid does not protect against typhoid, nor *vice versa*.

Infecting Agent.—The infecting agent is the bacillus paratyphosus A or B, belonging to a group of bacilli closely resembling the typhoid bacillus. A fundamental mark of differentiation between them is that each leave specific agglutination properties. The bacilli are usually present in the feces, urine, blood and bile of infected persons early in the disease, and often during the whole course.

Source of Infection.—The source of infection is the bowel discharges and urine of infected persons and foods contaminated with such discharges of infected persons or of healthy carriers. Healthy carriers may be numerous in an outbreak.

Period of Communicability.—The period of communicability is like that of typhoid fever, from the appearance of prodromal symptoms throughout the illness and relapses, during convalescence, and until repeated bacteriological examinations of the discharges show absence of the infecting organism.

Methods of control are similar to those used in typhoid fever.

DYSENTERY.

Dysentery may be divided into acute and chronic or bacillary and amebic dysentery.

A. Bacillary Dysentery.—This disease is distributed over the whole world. This is the form of dysentery that prevails in ships, camps jails, etc. The usual summer diarrheas of children are not bacillary dysentery, but are due mostly to improper feeding or clothing or unhygienic practices. They are largely communicable, however, and for this reason they should be made reportable and treated as infectious diseases so as not to transmit slightly pathogenic streptococci and colon bacilli.

Infective Agent.—The infective agent is the bacillus dysenteriæ of Shiga or other allied strains, which develop only in the intestines.

Source of Infection.—The source of infection is the bowel discharges of infected persons.

Mode of Transmission.—The mode of transmission is by drinking contaminated water, and by eating infected foods, and by hand-to-mouth transfer of infected material, also from formitus or objects soiled with discharges of an infected individual or a carrier. Flies, vermin, etc., may act as mechanical carriers of infection.

Incubation Period.—The incubation period is from two to seven days.

Period of Communicability.—The period of communicability is during the febrile period of the disease and until the organism is absent from the bowel discharges.

Methods of Control.—1. *Recognition of the disease* by the clinical symptoms, confirmed by serological (agglutination) and bacteriological tests.

2. *Isolation* of infected individuals during the communicable period of infection.

3. *Immunization.*—Vaccines give considerable immunity, but owing to the severe reactions produced their use is not general, nor should they be made compulsory except under extreme emergency. Immune sera have been used with apparently good results when employed early in the disease. A polyvalent serum should be used until the strain type is identified.

General Measures.—1. Reject personal prophylaxis of attendants upon infected persons.

2. No milk or food for human consumption should be sold from a place occupied by a patient unless the persons engaged therein occupy quarters separate from the house where the patient is sick, and all utensils used are cleansed and kept in a separate building, and under a permit from the health officer.

3. All attendants upon persons affected with this disease should be prohibited from having anything to do with the handling of food.

4. Necessary precautions should be taken against flies.

B. Amebic Dysentery.—Amebic dysentery (*amebic colitis* or *enteritis*) is a chronic infection, commencing insidiously, and characterized by relapses and recurrences. It is frequently associated with sequelæ, such as abscesses of the liver. The disease occurs sporadically or in endemic foci, mainly in the tropics. There are no epidemics of amebic dysentery. It is particularly prevalent in Egypt, India and the Philippine Islands, but occurs also in parts of South America and the Southern United States. A few cases have been reported in the Northern United States and in Europe. Where it is endemic, the largest number of cases occur after the heavy rains have set in during early summer. Males are more frequently attacked than females, probably because more exposed to infection. It may occur at all ages, but young adults seem most susceptible. The foreign white race appear to be less resistant to infection than the natives.

Infective Agent.—The infective agent is the ameba or entameba histolytica.

Source of Infection.—The source of infection is the bowel discharges of infected persons.

Mode of Transmission.—The mode of transmission is by drinking contaminated water and by eating infected foods, and by hand-to-mouth transfer of infected material; from objects soiled with discharges of an infected individual, or of a carrier; and by flies, etc. Unhygienic surroundings are generally a predisposing factor, but in the Philippines individuals of all classes are likely to be attacked who do not take continuous and extra precautions regarding their drinking water.

Incubation Period.—The incubation period is unknown.

Period of Communicability.—The period of communicability is during the course of the disease and until repeated microscopic examinations of the stools show absence of the ameba histolytica.

Method of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by the clinical symptoms, confirmed by microscopic examination of the stools, to be made as soon as possible after they are passed.

2. *Immunization.*—None.

3. *Concurrent disinfection* of the bowel discharges as in typhoid fever.

II. General Measures.—1. Boil all drinking water unless the supply is known to be free from contamination.

2. The water supply should be protected against contamination, and supervision should be exercised over all foods eaten raw.

Ipecac or its alkaloid emetin has been found to be practically a specific curative treatment when the ameba are in the vegetative stage, but it does affect the cysts.

Differential Diagnosis Between Amebic and Bacillary Dysentery.—In amebic dysentery: (1) the disease is usually chronic; (2) the ameba histolytica are usually found in the feces; (3) no severe toxic symptoms are present; (4) abscess of the liver is a frequent sequela; (5) the lesions are found in the cecum and descending colon, not in the small intestine. In bacillary dysentery, the finding of the bacilli, and a positive agglutination test, together with the clinical symptoms of intoxications make a certain diagnosis. Both infections may exist at the same time.

CHOLERA.

Infective Agent.—The infective agent is the vibrio choleræ or "Comma bacillus" of Koch. It is found only in the intestines, not in the blood or internal organs of infected persons.

There is scarcely any country in the world that has not been visited at some time or other by this fatal affection. The last severe epidemic in Europe was that of Hamburg, Germany, in 1892, when the disease threatened to become pandemic. A few cases, following the routes of trade were brought to New York by the transatlantic liners, but

aggressive preventive measures soon checked the spread of the infection. Cholera has prevailed for years in the Philippines, but is now under control.

Source of Infection.—The source of infection is the bowel discharges and vomitus of infected individuals, and the feces of convalescents or healthy carriers. These carriers are very common; 10 per cent. of contacts may be found to be carriers. The carriers' condition lasts only a few days or weeks.

Mode of Transmission.—The mode of transmission is by food and water polluted by the infective agent, by contact with infected persons, carriers or articles freshly soiled by their discharges, and by flies.

The two fundamental facts in the transmission of infection are that the vibrios leave the body only in the feces, and that the mode of infection is by way of the mouth. The feces of the cholera patient during the acute stage of the disease are extremely rich in vibrios, which are at present in almost pure cultures. As the case recovers they decrease in number, but persist after recovery for a short time. That is, chronic carriers do not exist. These persons constitute the "convalescent carriers." Mild cases which are undiagnosed or overlooked may thus become a source of danger. Another group of persons may act as sources of infection; these are the "healthy carriers" who excrete cholera vibrios in their stools. Not all persons who ingest cholera develop the disease. In a number of these, the vibrio will multiply in the intestine to a limited extent and be excreted in the stools, although no clinical evidences of the disease are present. Such healthy carriers are important not only as insidious spreaders of infection, but they may be potential cases of cholera, should their resistance be lowered.

The susceptibility to infection of different individuals varies and conditions may lower or raise the resistance of the individual. The resistance depends partly on antibodies and partly on the health of the person. Gastric and intestinal disorders due to indiscreet eating and drinking, or other causes, undoubtedly favor infection, or in the case of healthy carriers may cause the development of cholera.

Incubation Period.—The incubation period of the disease is from one to five, usually three days, occasionally longer if the healthy carrier stage, before development of symptoms is included.

Period of Communicability.—The period of communicability is usually seven to fourteen days and occasionally longer.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease by the clinical symptoms confirmed by bacteriological examination,* viz., isolation and identification of the cholera vibrio in pure culture. A presumptive diagnosis of cholera may be made by finding large numbers of comma-shaped bacilli in direct microscopic examination of stained preparations or in hanging drops of the mucous flakes found in cholera stools. But this is only presumptive and cannot be dependent upon. The only positive diagnosis consists in the biological reactions of the microörganisms

obtained in pure culture, the most reliable tests being the agglutination test with a known serum.

2. *Isolation* of the patient in a special hospital or screened room with trained attendant.

3. *Immunization.*—A vaccine similar to the typhoid vaccine was suggested by Haffkine. The use of the vaccine gives a considerable degree of immunity. In those who have been attacked the mortality of the disease has been reduced, viz., from 75 per cent. among the unvaccinated to 42 per cent. among the vaccinated. The duration of mmunity is about a year.

4. *Quarantine* is justified for the prevention of this disease. All contacts, or persons who have been exposed to infection, should be quarantined for five days from the last exposure.

5. *Concurrent Disinfection.*—This includes prompt and thorough disinfection of the stools and vomited matter by formalin (10 per cent.), carbolic acid (5 per cent.), milk of lime (1 to 8) or chlorinated lime (3 per cent.) All articles used by and in connection with the patient must be disinfected before removal from the room. Remnants of food left by the patient must be burned.

6. *Terminal Disinfection.*—The bodies of those dying from cholera should be cremated if practicable, or otherwise wrapped in a sheet wet with a disinfectant solution and placed in water-tight casks. The room in which a sick person was isolated should be thoroughly cleansed by washing the surfaces with bichloride solution or creosote preparation and disinfected by treatment with formaldehyde gas.

II. General Measures.—1. Rigid personal prophylaxis of attendants by scrupulous cleanliness, disinfection of hands each time after handling the patient or touching articles contaminated by dejecta, the avoidance of eating or drinking anything in the room of the patient and the prohibition of those attendant on the sick from entering the kitchen.

2. Bacteriological examination of the stools of all contacts to determine carriers; and isolation of carriers.

3. Water should be boiled if used for drinking or toilet purposes, or if used in washing dishes or food containers unless the water supply is adequately protected against contamination or is so treated, as by chlorination, that the cholera vibrio cannot survive in it.

4. Careful supervision of food and drink. Where cholera is prevalent only cooked food should be used. Food and drink after cooking or boiling should be protected against contamination, as by flies and human handling.

III. Epidemic Measures.—Inspection service with laboratory for early detection and isolation of cases; examination of persons exposed in infected centers for detection of carriers, and the isolation or control of carriers; disinfection of rooms occupied by the sick; and the detention in suitable camps and barracks for five days, of those desirous of leaving for another locality. Those so detained should be examined for the detection of carriers.

THE VENEREAL DISEASES.

In their effects on the individual, on the State and on posterity, there is no other single disease or group of diseases which compares with syphilis and gonorrhea. The effects of these diseases on the individual are those due to the loss of efficiency and earning capacity. This loss in the population at large cannot be accurately determined, as no records have been kept of cases and deaths; so that the effects in civil life as a whole can only be approximated. There are, however, definite figures at hand for selected groups.

Recent reports from the Surgeon General of the Army state that no disclosures during the late war were more startling than those showing the destructive inroads of the venereal diseases on the health and efficiency of the soldiers and this was in spite of the greatest efforts put forth to prevent infection. From the time the United States entered the war in April, 1917 to September, 1918 the loss to the army from venereal diseases represented 2,295,000 days of service, and the venereal diseases in the Army were caused largely by conditions in civil life.

Moreover, one has but to consider the clinical manifestations of these diseases to appreciate the truth of this statement; hemiplegia, optic neuritis, iritis, tabes, general paresis, gonorrheal arthritis and gonorrheal endocarditis are but a few of the many effects of syphilis and gonorrhea.

Posterity suffers even more severely; the varying manifestations of congenital syphilis, such as deafness, interstitial keratitis and mental defectives are only too commonly met with. Twenty-five per cent. of blindness in children is due to gonorrheal opthalmia, and the cost to the State for the education of each blind child exceeds $4500. It is estimated that the total annual loss from gonorrheal ophthalmia in the United States is $7,000,000, and that more than $1,000,000 annually is spent in partially caring for its victims.

In addition to the effects on the individual members of the community the cost to the State is mainly an economic question. Millions of dollars have been expended yearly for the care of the insane, and from 10 to 20 per cent. of these are of syphilitic origin. There are probably not less than 15,000 potential paretics in the State of New York.

The cost of the venereal diseases includes not only the capital or earning power lost by death, but the waste of the vital forces of the individual, disabling him for weeks, months, or perhaps for years previous to death, and at the period of his greatest usefulness and productive capacity, and this cost falls largely upon others than the individual affected, namely, upon the employers of labor and the community generally. This cost is yearly on the increase.

The influence of syphilis and gonorrhea on vital statistics is undoubtedly large, although proof of this is impossible at present. These diseases are seldom given as cause of death on death certificates;

only the results. But these results show plainly the effects of the venereal diseases on the mortality-rates.

Let us consider first the effects on infant mortality. Mott reports one series of 34 mothers infected with syphilis in which there were 175 confinements, which yielded 104 infant deaths and 41 seriously diseased children; only 31 children were apparently healthy. Another series of 1001 pregnancies, reported by the same writer, resulted in 172 stillbirths and 229 infant deaths; of the 600 children who lived only 200 were healthy. It is estimated that stillbirths are three times as frequent among syphilitic women as among the non-syphilitic. The birth-rate of any community would no doubt be considerably higher if it were not for the sterility resulting from gonorrheal salpingitis and oöphoritis in the female and epididymitis in the male.

It has long been recognized that certain diseases such as aortic aneurysm, cerebral apoplexy in early life (before the age of forty), tabes, and general paresis were syphilitic in origin, but the recent investigations of Warthin have clearly demonstrated that many other conditions heretofore unsuspected, are due to the same cause. In 40 per cent. of 750 autopsies made by this investigator, syphilitic lesions were found in various tissues, such as the heart muscle, the arterial walls and other viscera. Without question syphilis is a contributory cause, if not the actual cause, of death in a great many of these cases.

In the same way gonorrheal infection, though rarely appearing as a cause of death in cases of acute endocarditis, is a contributing cause of death in a great many of these cases. Cystitis with subsequent septicemia often has its inception in a strictured urethra. Women not infrequently die as the result of pus infection of the tubes and ovaries, which were originally infected by the gonococcus.

This group of diseases constitutes the greatest of modern plagues. They are both preventable and curable; yet so vast is the extent of the social evil, so deeply is this problem rooted in private life, and so closely is it interwoven with other kindred problems still awaiting solution, such as prostitution and alcoholism, that at times it would seem almost hopeless to expect ever to solve it at all. Indeed, until New York City, in 1912, determined to treat the venereal diseases as any other communicable and preventable infection, regarding them only from a public health standpoint, and ignoring their social and moral features, no serious effort was made by the sanitary authorities of any of our larger cities to solve the problem. Although progress against these diseases has been very slow, and the difficulties to be met and overcome, in this case, are much greater than in any other group of communicable diseases, it is believed that an intelligent campaign persistently carried on, along the lines of sanitation and hygiene, will eventually result in their successful, if long-delayed, control. The effort to do so at least must go on. The two principal venereal diseases are syphilis and gonorrhea, to which a third subordinate one may be added, viz., chancroid.

Syphilis.—Syphilis is a specific disease of slow evolution, propagated by inoculation (acquired syphilis). The infection itself, or various defects from the consequences of syphilis, may be transmitted (congenital syphilis) from parent to child, often with fatal results.

Syphilis in nature, so far as is known, appears only in man. The disease, however, has been produced in monkeys and rabbits by the inoculation of human virus. The course of the disease in man is divided into three stages: primary, secondary and tertiary. The initial or *primary lesion* occurs in the form of a papule which develops into the so-called chancre with hardened base. Following this there is hyperplasia of the nearest lymph nodes. These lesions subside and six or seven weeks later the *secondary lesions* appear in various general eruptions on the skin and mucous membranes and in constitutional disturbances. The *tertiary lesions*, which consist principally of the masses of new tissue called gummata are found throughout the viscera and in the periosteum. A *fourth stage* is often added, consisting of the sequelæ of syphilis, such as general paresis, arteriosclerosis, locomotor ataxia, aneurysm, etc. Schaudinn's spirochetes, the causative agent of the disease, have been demonstrated in practically all the lesions of syphilis, including the congenital type.

Natural immunity in syphilis is very peculiar. After the development of the primary lesion, man is usually insusceptible to inoculation during the active stage of the disease, but during all stages both man and monkey can, in some cases, be reinoculated. Reinoculation in the tertiary stage gives precocious lesions of the tertiary type, gummata and tubercles.

The infection in syphilis in the large majority of cases, is transmitted in venery, but non-venereal syphilis is more common than generally supposed by accidental or indirect contact with discharges from lesions.

Infectious Agent.—The infectious agent is the Treponema pallidum (Schaudinn and Hoffmann).

Source of Infection.—The source of infection is the discharges from the lesions of the skin and mucous membranes, and the blood of infected persons, and articles freshly soiled with such discharges or in which the Treponema pallidum is present.

Mode of Transmission.—The mode of transmission is by direct personal contact with infected individuals, and indirectly by contact with discharges from lesions. Rarely it may be contracted from infected utensils.

Incubation Period.—The incubation period is about three weeks.

Period of Communicability.—The period of communicability is as long as the lesions are open upon the skin or mucous membranes and until the body is freed from the infecting organisms, as shown by microscopic examination of material from ulcers and by serum reactions.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by the clinical symptoms, confirmed

by microscopical examination of discharges and by serum or spinal fluid (Wassermann) complement-fixation reactions.

2. *Isolation.*—Exclusion from sexual contact and from preparation or preserving of food during the early and active period of the disease, otherwise none, unless the patient is unwilling to heed, or is incapable of observing, the precautions required by the medical adviser.

3. *Immunization.*—None.

II. General Measures.—1. *Education in matters of sexual hygiene,* particularly as to the fact that continence in both sexes and at all ages is compatible with health and development.

2. *Provision for accurate and early diagnosis and treatment* in hospitals and dispensaries, of infected persons, with consideration for privacy of record, and provision for following cases until cured. Facilities for physicians to have Wassermann tests made by Departments of Health.

3. *Repression of prostitution* by use of the police power and control of use of living premises.

4. *Restriction of the sale of alcoholic beverages.*

5. *Restriction of advertising* of services or medicines for treatment of sex diseases, etc.

6. *Abandonment* of the use of common towels, cups, and toilet articles and eating utensils.

7. *Exclusion of persons in the communicable stage* of the disease from participation in the preparing and serving of food.

8. *Personal prophylaxis* should be advised to those who expose themselves to opportunity of infection. (Calomel ointment, $33\frac{1}{3}$ per cent., applied within an hour of intercourse is generally effective in preventing syphilitic infections.)

Gonorrhea.—Gonorrhea is a specific disease communicated by contact infection; in almost all cases among adults it is transmitted by sexual intercourse. It is more prevalent than syphilis and though in many cases quickly recovered from it often leads to most serious lesions. The total harmful effect on the race probably equals that of syphilis. Gonorrheal infection is usually restricted to the mucous membranes of the urethra, prostate, neck of bladder, cervix uteri, vagina, and conjunctiva. The conjunctival, vaginal and rectal mucous membranes are much more sensitive in early childhood than in later life. Gonorrheal ophthalmia is thus a frequent accidental infection at birth, and vaginitis in the young child is often produced by the carelessness of the nurse or mother carrying the infection.

The usual course of the inflammation is as follows: The infection first takes place upon the mucous membranes which show congestion, infiltration with serous exudate and accumulation of leukocytes. It then penetrates the epithelial layer down to the submucous connective tissue. Recovery or prolonged chronic inflammation may then occur. The original infection of the urethra or vagina and cervix may remain localized or spread to adjacent parts, or through the blood, be carried to all parts of the body. The complications and sequelæ of gonorrhea may thus be endometritis, metritis, salpingitis, oöphoritis, peritonitis,

prostatitis, cystitis, epididymitis and arthritis. Abscesses of considerable size, periostitis and otitis are occasionally due to this infection. Cases of gonorrheal endocarditis and septicemia are not infrequent. General gonorrheal infections are often followed or accompanied by neuralgic affections, muscle atrophies and neuritis. Gonorrhea is more frequent in males than in females, but gonorrheal arthritis of great intensity may occur in a newly married woman infected by an old gleet in her husband (Osler). There is no limit to the time during which a man or woman may remain infected with gonorrhea and infect others. We have had one case under observation where twenty years had elapsed since exposures to infection, and yet the gonococci were still abundant. It is now well established that most of the inflammations of the female genital tract are due to gonorrhea, and the majority of such infections are produced in innocent women by their husbands who are suffering from the latent disease. At least one-half of all cases of sterility is said to be caused by gonorrhea. Immunity after recovery from the disease seems to be only slight in amount and for a short period, if present at all.

Infectious Agent.—The infectious agent is the gonococcus (Neisser).

Source of Infection.—The source of infection is the discharges from lesions of inflamed mucous membranes and glands of infected persons, viz., urethral, vaginal, cervical, conjunctival mucous membranes and Bartholin's or Skene's glands in the female, and Cowper's and the prostate glands in the male.

Mode of Transmission.—The mode of transmission is by direct personal contact with infected individuals, and indirectly by contact with articles freshly soiled with the discharges of such individuals.

Incubation Period.—The incubation period is from one to eight days, usually three to five days.

Period of Communicability.—The period of communicability is as long as the gonococcus persists in any of the discharges, whether the infection be an old or a recent one.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by the clinical symptoms, confirmed by bacteriological examination or serum reaction (Complement-fixation test).

The bacteriological examination by smears and cultures usually fails to distinguish gonococci in the subacute and chronic cases. This is especially true in female cases. The complement-fixation test when properly carried out often gives valuable information in these cases when it is positive infection probably persists.

2. *Isolation.*—When the lesions are in the genito-urinary tract, exclusion from sexual contact, and when the lesions are conjunctival, exclusion from school or contact with children, as long as the discharge contains the infecting organism.

3. *Immunization.*—None

II. General Measures.—1. *Education in matters of sexual hygiene,* particularly as to the fact that continence in both sexes at all ages is compatible with health and development.

2. *Provision for accurate and early diagnosis*, and treatment in hospital and dispensaries of infected persons with consideration for privacy of record and provision for following cases until cured.

3. *Repression of prostitution* by use of police power and control of use of living premises.

4. *Restriction of the sale of alcoholic beverages.*

5. *Restriction of advertising* of services or medicines for the treatment of sex diseases, etc.

6. *Elimination of common towels* and toilet articles from public places.

7. *Use of prophylactic silver solution* in the eyes of the newborn (Credé's method).

8. *Exclusion of persons in the communicable stage* of the disease from participation in the preparing and serving of food.

9. *Personal prophylaxis* should be advised to those who expose themselves to opportunity of infection (*e. g.*, silver salts—injections of argyrol 10 per cent. solution).

10. *Prevention of Ophthalmia Neonatorum.*—This disease is usually but not always due to the gonococcus during pregnancy, women should daily cleanse the external parts with soap and water on a clean cloth. Immediately after birth when there is a possibility that the mother is infected, the eyelids should be carefully cleansed with a saturated solution of boric acid on a swab of sterile gauze or absorbent cotton. A separate piece of cotton should be used for the lids of each eye. The lids should then be separated and one or two drops of a 1 per cent. solution of nitrate of silver dropped in each eye. The head should be so held and the lids separated so that the solution may lie for from one half to one minute upon them, so as to come in contact with every part.

Substitutes such as 25 per cent. solution of argyrol and aqua chlorine are sometimes substituted.

Chancroid.—Chancroid is a specific ulcer, caused by the Ducrey bacillus of soft chancre.

The ulcers are often multiple and confer little or no immunity. They are local, and unless complications set in they produce no sequelæ or constitutional disturbances. But chancroids are peculiarly liable to mixed infections, from which serious consequences may result. Among the complications of the ulcers are: phimosis, destruction of the frenum, gangrene, lymphangitis and inguinal adenitis (buboes). This infection is thus not always mild or trivial, and the same methods of control should be adopted for preventing it as in the case of the other venereal diseases.

(The ulcer may be aborted by cauterization if not more than three days old, as advised by Keyes: Wash the ulcers with hydrogen peroxide, dry, apply carbolic acid (pure), and then nitric acid (pure); wash again with hydrogen peroxide and dust with calomel. Soap and water applied at time of exposure will prevent the development of chancroid.)

General Discussion on the Control of the Venereal Diseases.—The venereal diseases being highly infectious and communicable, it stands

to reason that similar measures must be adopted for their control as are employed for the control of other communicable disease.

These measures may be grouped under four headings:

I. Isolation and treatment of active cases of the diseases.
II. Isolation and control of carriers.
III. Control of the environmental factors necessary for the dissemination of the disease.
IV. Public Health education in reference to the disease.

I. The patient suffering with syphilis or gonorrhea should be subjected to such a degree of isolation as may be necessary for the individual case. The intelligent person may need nothing more than instruction in the proper method of disinfection of the infective discharges and in the precautions which must be taken to prevent the spread of the disease. On the other hand, the less intelligent patient may require strict isolation until the infective stage of the disease is past.

Early and skilful treatment is essential in controlling the spread of the venereal diseases; every case of syphilis or gonorrhea promptly and properly treated means not only one more case under supervision, but one less source of infection.

To secure this result requires the suppression of two great evils: the patent medicine and the venereal quack. Since both of these owe their existence solely to advertising, they should be abolished by appropriate legislation forbidding their publication. This would also tend to discourage self-treatment and drugstore treatment, which are ineffective and help to keep alive sources of infection. The laws regarding dispensing of drugs without a prescription should be strictly enforced, in which physicians and druggists can greatly assist.

To be successful, facilities for skilful treatment of the venereal diseases must be provided. The burden of this is placed entirely upon the medical profession, each individual member of which must either so perfect himself in the modern methods of diagnosis and treatment of the diseases that he is able to give his patient the skilful service required or he must be willing to refer the patient to some other physician who is competent to render such service.

Since the morbidity of the venereal diseases is just as high among the poor as among the well-to-do, if not more so, provision should be made for treatment without expense of those who have not the means of paying.

The Royal Commission on Venereal Diseases, as the result of its investigation of 1913–1916 in England, included in its report recommendations that each Borough and County in the Kingdom of Great Britain should establish "treatment centers" where care could be taken of the indigent; the expense of which was to be borne three-fourths by the Royal Government and one-fourth by the local authorities.

In the United States like steps have recently been taken under the direction of the Interdepartmental Social Hygiene Board. A sum of $1,000,000 was appropriated by Congress to be used in the various

States (distributed in proportion to the population) for the suppression of venereal disease. During the first year of the appropriation the money was given to the States without provisional State appropriation. For the year 1919–1920 each State is required to furnish an equal amount in order to secure its allotment of the appropriation. These funds are divided into budgets, viz., for treatment, for education in social service, for repression, etc. As a result of this Federal activity, clinics and dispensaries have been established in many States and municipalities, and their value is becoming more and more apparent each month.

II. The second step necessary to control the spread of the venereal diseases consists in measures for the control of chronic carriers of disease. The active case must remain under treatment until cured, and not dismissed as clinically well and in a carrier condition; clinical evidence is no evidence of cure. Laboratory tests alone are proof of cure, and even here negative results cannot be depended upon. Many States have now a provision in their laws which requires an individual who is being treated for a venereal disease to report at regular intervals to his physician. If such conduct on the part of the patient is not adhered to, the physician is then empowered to report his name to the health authorities who take action in the case.

In order to obtain knowledge of the whereabouts of carriers of venereal disease, some form of reporting cases is necessary. The most important item of such a report is a statement as to the source of infection. The system most commonly used is known as the Australian system, whereby a patient is reported by serial number, the name to be divulged only if the patient refuses to conform to the regulations of the health authorities. Upon receipt of this report the health officer is expected to communicate with the person named as the source of infection, with the object of confirming or disproving the statement and of treating the individual if found to be infected. Procedures of this kind have been tried and proved to be successful.

Again, the health authorities should have the right to examine persons whom they may have reasonable grounds to suspect of being infected with venereal disease. It needs no argument to prove that the prostitute would always be a member of this group. Such a person should be examined and if found infected should be treated until cured. In the meantime the individual should be strictly isolated, for as a general rule the prostitute depends entirely upon the proceeds of her trade and is incapable of self-support by any other means.

Certain occupations, such as those of barbers, manicurists, masseurs, should be forbidden to persons suffering with syphilis; and no case of gonorrhea should be allowed to engage in any occupation in which he or she may be brought into contact with children.

III. The third important factor to control the spread of the venereal diseases is the suppression of those influences which aid in the dissemination of these diseases. This is a social aspect of the problem. It involves the question of better housing conditions, of the control of the

liquor traffic, especially of the "back-room" variety, of the supervision of parks and dance halls, and, greatest of all, the abolition of the red-light district.

It has been thought in the past by well meaning persons that segregation of prostitution was the proper solution of a necessary evil. But the reverse has been proved many times; particularly has this been shown in connection with the Army during the recent war. It has been demonstrated beyond question that the venereal disease rate in the army is far less than in the civilian population, and activities directed against the segregated districts have lowered the morbidity in many cases in the surrounding community. Some hold that the woman in the house of prostitution takes better care of herself than the "street walker." This may be so, but if the woman is infected she will surely infect more men in any given time in the house of prostitution than will the street walker, for her opportunities are from three to ten times as great. Furthermore, the red-light district creates its own market; men who might otherwise refrain from such association may be tempted by the segregated district as being easier of access. Lastly, it has been shown that the number of street walkers lessens with the abolition of the segregated district. The registration and examination of prostitutes does not insure health, such examination being cursory at best. Infection may occur immediately after examination and not be discovered for days. In addition to giving a false sense of security, it does not reach the clandestine prostitute, the chief source of venereal infection. The elimination of prostitution has been called "a dream of the theoretical reformer." Nevertheless it is our duty to take cognizance of existing prostitution and, wherever found, to do everything in our power to eradicate it.

Alcohol is inextricably bound up with the venereal problem. Venus and Bacchus have ever been associates. The physiological effect of alcohol is to excite the organs of reproduction at the same time that it lowers the moral sensibilities and diminishes the will-power to resist temptation. With the advent of prohibition or the control of the manufacture of alcohol as a beverage, it would seem that there should be a consequent reduction of venereal diseases.

Experience in the Army, however, has shown that one cannot remove all these environmental factors without furnishing some substitutes for them. The activities of the Young Men's and the Young Women's Christian Associations, and various other organizations, have yielded wonderful results among the soldiers in this respect. Wholesome recreation must be provided to take the place of harmful amusements. Supervised dancing must replace the disreputable dance halls; club-rooms must replace the saloons; outdoor playgrounds must replace the dives, and these should be provided at community expense if we are to profit by the lessons which the war has taught us.

IV. It is an accepted rule in public health that measures of control cannot progress far in advance of public opinion. The public has so long been kept in ignorance of the extent, nature and dangers of the

venereal diseases, that education is necessary to gain their support and coöperation in the prevention of these diseases. Heretofore this subject was not considered one suitable for decent people to discuss; children have grown up in ignorance of the true facts or learned what they knew, much of it incorrect and harmful, from companions as ignorant as themselves, on the street or in school; and in the meantime the plague has extended.

Recently a campaign of education in social hygiene has been inaugurated which is nation-wide, and the public has been found in a receptive mood. The people have been approached in all possible ways, by moving pictures, stereopticon lectures, pamphlets, circulars, posters, letters and personal appeals. In the last analysis it is by means of public health education that our goal will be achieved. Then the demand for drastic regulations to control the venereal diseases will be made by the public and these regulations will be enforced, which in turn will lessen the need of such health legislation.

Individual Prophylaxis.—As a result of the experiments of Metchnikoff and Roux with syphilitic inoculation of the higher apes, it was found that syphilitic infection could be aborted by use of certain prophylactic measures. These consist of thorough washing with soap and water followed by inunction of the genitals with $33\frac{1}{3}$ per cent. calomel ointment, the ointment to be left on the skin for eight hours or more. It has been shown that an injection of 25 per cent. argyrol into the urethra will in like manner prevent gonorrhea. To insure success in individual prophylaxis it should be accomplished within two hours after exposure. After eight hours its effect is practically nil.

TETANUS.

Tetanus ("lock-jaw") is an infectious disease, characterized by a gradual onset of general spasm of the voluntary muscles, commencing in those of the jaw and neck, and extending in severe cases to the muscles of the body. The disease is usually associated with a wound. Like diphtheria, tetanus is a type of the true toxemias.

The disease has long afflicted man, having been clearly described by Hippocrates. The specific causative agent, the bacillus of tetanus, occurs widely disseminated throughout the world as a common inhabitant of the soil, especially garden earth where manure has been thrown. It is abundant in many places not only in the superficial layers of the soil, but also at the depth of several feet. It has been found in various substances, such as hay-dust, horse and cow manure (its normal habitat is the intestines of herbivora) in the dust of rooms in houses, barracks and hospitals. The bacilli are more numerous in some localities than in others, for example, in certain parts of Long Island and New Jersey, they are fairly common in New York City. As a rule, they are most abundant in regions where the temperature is high as in the tropics, where cases of puerperal tetanus and tetanus neonatorum

are very frequent. Tetanus bacilli are found in the intestines of about 15 per cent. of horses and calves living in the vicinity of New York City. They are also present to a less extent in the intestines of other animals. and of man. The term "idiopathic tetanus" is used when the site of the bacillus is unknown.

Although tetanus may be regarded as almost entirely a wound complication, all wounds are not equally susceptible to the infection. Punctured, lacerated and contused wounds are much more liable to become infected than clean-cut or superficial wounds. Fatal tetanus may develop from slight scratches, small splinters, insect bites, vaccinations, etc. The wounds produced by blank cartridges are especially liable to develop tetanus, due to the peculiar character of the wound. The number of cases of tetanus following Fourth of July wounds has recently decreased owing to the campaign carried on by the American Medical Association for a safe and sane celebration, the more thorough and careful treatment of the wounds, and especially the use of tetanus antitoxin as a prophylactic.

Infecting Agent.—The infecting agent is the Bacillus tetani.

Source of Infection.—The source of infection is animal manure, and soil fertilized with animal manure, and, rarely the discharges from wounds.

Mode of Infection.—The mode of infection is by inoculation or wound infection.

Incubation Period.—The incubation period is six to fourteen days, usually nine days.

Period of Communicability.—The patient is not infectious except in rare instances where wound discharges are infectious.

Methods of Control.—I. The Infected Individual and His Environment.—1. *Recognition of the disease* by the clinical symptoms, which may be confirmed bacteriologically.

2. *Immunization* by antitoxin, single or repeated injections.

II. General Measures.—1. *Supervision of the* practice of obstetrics.

2 *Educational propaganda,* such as a "safety-first" campaign, and "safe, and sane Fourth of July" campaign.

3. *Prophylactic use of tetanus antitoxin* where wounds have been acquired in regions where the soil is known to be heavily contaminated, and in all cases where wounds are punctured, lacerated or contused.[1]

4. *Supervision of biological* products, especially vaccines and sera.

5. *Removal by thorough treatment* of all foreign matter from wounds as early as possible. If symptoms of tetanus, give antitoxin.

[1] In every case strongly suspected of being tetanus, from 3000 to 5000 units of tetanus antitoxin should be given at the first possible moment intraspinally, slowly by gravity, and always, if possible, under an anesthetic. To insure its thorough dissemination throughout the spinal meninges the antitoxin should be diluted if necessary, to a volume of from 3 to 10 c.c. or more, according to the patient's age. When fluid is drawn off previously to the giving of the antitoxin an amount of the latter somewhat less than that of the fluid withdrawn should be given. In cases of "dry tap" only a small amount of tetanus antitoxin should be injected (3 to 5 c.c.).

MALARIA.

The discovery by Laveran that the mosquito was the intermediate host that conveyed the parasites of malaria to man was one of the most important ever made. Malaria is most severe and prevalent in the tropics, but may be present in any part of the world where the anopheles can breed. It is most prevalent near the equator.

There is little, if any, direct communicability. The one infected may think himself cured and have relapses. In malarious regions many children are carriers without apparently showing any disturbances. These are a constant source for mosquito infection. Exposure, overeating and anything which lowers resistance predispose to relapses and to the probability of infection. The difficulties of destroying the anopheles in extensive areas is very great. Where population is fairly dense it can be done. Where sparse, the treatment with quinine of carriers by suppressing the source of mosquito infection is the most promising method and will accomplish much and should be accompanied by quinine treatment as a preventive for the well. The adult dose is usually 5 to 7 grains daily. Drainage and treatment of low places by filling in offer the best success. Bass found that 90 per cent. of malaria could be eliminated from any region, if physicians, health officers and public worked together to diminish it.

Infectious Agent.—The several species of malarial organisms—Plasmodium malariæ, P. vivax and Laverania malariæ.

Mode of Transmission.—By bite of the infected Anopheles mosquitoes (Figs. 18 and 20). The mosquito is infected by biting an individual suffering from acute or chronic malaria. The parasite develops in the body of the mosquito for from ten to fourteen days, after which time the sporozoites appear in its salivary glands.

Incubation Period.—Varies with the type of species of infecting organism and the amount of infection; usually fourteen days in the tertian variety.

Period of Communicability.—As long as the malaria organism exists in the blood.

Methods of Control.—The Infected Individual and His Environment.—1. *Recognition of the Disease.*—Clinical symptoms, always to be confirmed by microscopic examination of the blood. Repeated examinations may be necessary. Quinine in sufficient doses should be continued until cures are established. It is estimated that persons who have second attacks during the year suffer in at least 50 per cent. from relapses and not new infections. Bass recommends ½ grain of quinine every night before retiring for infant of one year; 3 grains, five years; 8 grains, fifteen years, and 10 grains for older persons. The treatment to be continued for eight weeks. About 40 per cent. of all infected persons do not realize it. These and those who treat themselves insufficiently are the ones who keep up the infection.

2. *Isolation.*—Exclusion of patient from approach of mosquitoes, until his blood is rendered free from malarial parasites by thorough treatment with quinine.

3. *Immunization.*—None. The administration of prophylactic doses of quinine should be insisted upon for those constantly exposed to infection and unable to protect themselves against mosquitoes.

4. Destruction of Anopheles mosquitoes in the sick room during illness and after recovery.

II. General Measures. — 1. Employment of known measures for destroying larvæ of anophelines and the eradication of breeding places of such mosquitoes. There are drainage, filling in hollows, modifying streams, oiling by kerosene every ten days, screening wells, cisterns, etc., removal of plants likely to contain water, introduction of fish, etc.

2. Blood examination of persons living in infected centers to determine the incidence of infection.

3. Screening sleeping and living quarters and use of mosquito nets in order to reduce the number of infections in man and mosquitoes.

4. Killing mosquitoes in living quarters.

YELLOW FEVER.

The yellow fever mosquito is distributed between the latitude of 38 degrees south and 38 degrees north. It is found abundantly south of the Potomac River along the coast. It is absent in the higher elevations of Georgia and Alabama. The mosquito breeds by preference in any standing water about the house grounds, such as cisterns, rain barrels, empty jars, etc. It does not breed in swamps and does not fly to any great distance. It is chiefly active by day. It cannot pass a screen composed of 19 strands to the inch.

Infectious Agent.—Unknown. Noguchi claims that a spirochete (Leptospira icteroides) discovered by him is the probable cause.

Source of Infection.—The blood of infected persons.

Mode of Transmission.—By the bite of infected Aedes calopus mosquitoes.

Incubation Period.—Three to five days, occasionally six days.

Period of Communicability.—First three days of the fever.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the Disease.*—Clinical symptoms.

2. *Isolation.*—Isolate from mosquitoes in a special hospital ward or thoroughly screened room. If necessary the room or ward should be freed from mosquitoes by fumigation. Isolation necessary only for the first three days of the fever.

3. *Immunization.*—None.

4. *Quarantine.*—Contacts for six days.

5. *Concurrent Disinfection.*—None.

6. *Terminal Disinfection.*—None. Upon termination of case the premises should be rendered free from mosquitoes by fumigation.

II. General Measures.—Eliminate mosquitoes by rendering breeding impossible. Removal of all vessels, tubs, etc., that hold stagnant water. Introduction of suitable and abundant fish to feed on larvæ.

FIG. 13

FIG. 14

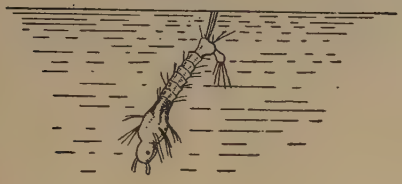

FIG. 15

FIG. 16

FIG. 17

FIG. 18

FIG. 19

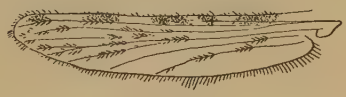

FIG. 20

FIG. 21

FIG. 22

Chief comparative characteristics of culex and anopheles. Egg of culex, Fig. 13, laid together in "small boat," those of anopheles, Fig. 14, separate and rounded. Larva of culex, Fig. 15, hangs nearly at right angles to water surface, those of anopheles, Fig. 16, are parallel to surface. Body of culex, Fig. 17, when resting is held parallel to wall in a curved position, that of anopheles, Fig. 18, stands at an angle of about 45 degrees and is straight; wings of culex, Fig. 19, are generally not spotted, those of anopheles, Fig. 20, are spotted. In culex the palpæ, Fig. 21, of the female are very short, of the male are longer than the proboscis; in anopheles, Fig. 22, the proboscis of both sexes are about of equal length. (From Kolle and Hetsch.)

III. Epidemic Measures.—1. Inspection service for the detection of those ill with the disease.

2. Fumigation of houses in which cases of disease have occurred, and of all adjacent houses.

3. Destruction of Aedes calopus mosquitoes by fumigation; use of larvicides; eradication of breeding places.

RABIES.

Rabies (Hydrophobia.)—An acute infectious disease of mammals dependent upon a specific virus, and communicated to susceptible animals by the saliva of an infected animal through abrasion of skin or mucous membranes almost always by bites or scratches.

Within the gray nervous tissue of rabid animals are peculiar protozoön-like structures known as "Negri bodies" which are diagnostic of rabies. They are thought by some to be the probable exciting factor, although this is disputed by others.

Incidence.—Rabies exists in almost all parts of the world. The only country in which it has never been known is Australia, probably because there are but few marsupial animals there, and dogs have always been under strict control. Hydrophobia is very rare in Norway, Sweden, Denmark, Holland, Switzerland and North Germany, where dog laws are in force; while it is most common in Russia, France, Belgium, Italy and Austria where such laws are lax or absent. The disease is comparatively infrequent in South America, Mexico and Canada, in this part of the world; but in the United States it is apparently on the increase, owing to the general neglect of legislative measures for the control of rabies Recently the disease has been eradicated from England by the enactment of laws requiring the muzzling and later quarantine of dogs coming into the country.

All warm-blooded animals are more or less naturally susceptible to hydrophobia, but it occurs most frequently in dogs, among domestic animals, and in wild animals of the canine species, such as wolves, foxes, jackals and hyenas. It occasionally occurs in cats and skunks, more rarely in cattle, sheep, goats, horses, cows and pigs.

Rabies is one of the most fatal diseases, recovery seldom or ever taking place after the symptoms become developed.

The disease occurs at all seasons of the year, although it is commonly supposed to prevail most in the hot months of summer, the reason for this being simply that dogs are liable to run abroad more freely at this time than in the winter. Hot weather has no influence on the disease; cold, indeed, seems to aggravate it.

Neither age, sex, nor other conditions have any effect upon the production of the disease in man, but occupation, so far as this relates to exposure to infection, may possibly influence the number of cases. Thus those persons who are much in the country or on the streets, or in other words, those who might come most often in contact with rabid animals, most commonly contract the disease.

Transmission.—While all mammals are subject to rabies, the disease is transmitted and disseminated, in civilized countries at least, almost exclusively by dogs. The virus is contained in the saliva of the rabid animal, and is usually communicated to man through a bite. The bite of such infected animal may produce the disease from eight to fifteen days before the symptoms of rabies develop. Hence if an animal be kept under observation for three weeks after the bite without developing symptoms, he may be pronounced free of rabies.

The certainty with which the disease may be produced after a bite and the rapidity of its development have been found to depend: (1) on the quantity of the rabic virus introduced; (2) on the point of inoculation; and (3) on the strength of the virus as determined by the kind of animal which affords the cultivation ground for the development of the poison. It has been observed in man that slight wounds of the skin, of the limbs, and of the back, or wherever the skin is thick and the nerves few, either produce no results, especially when bites are through the clothing, or are followed by the disease after an extremely long period of incubation; while in lacerated wounds often tips of the fingers where small nerves are numerous, or where the muscles and nerve trunks are reached, or in lacerated wounds of the face where there is also an abundance of nerves, the incubation period is usually much shorter and the disease generally more severe.

These facts explain why only about 16 per cent. of human beings bitten by rabid animals, and untreated, appear to contract hydrophobia. They also explain why the bites of savage animals like wolves are the most dangerous because of the torn and lacerated nature of the wounds produced.

Infection, however, may be caused in other ways than through bites. The mere licking of the bare hand or face; if they have a slight scratch or abrasion, by a rabid animal may result in infection. There is special danger from this source in handling sick dogs, when they show no definite symptoms, or possibly only a slight suspicion of beginning rabies. In handling such animals, therefore, the hands and face should be properly protected. Infection may also take place in dissecting a rabid animal that has died of the disease or been killed.

Incubation.—There is always a period of incubation after the bite of quite variable duration. As a rule it is from twenty to sixty days. The shortest period recorded is fourteen days and the longest authentic period is seven months. A few cases have been reported as developing after a year or more, but these cases may be considered as of doubtful authenticity.

The wound heals like any other wound and sometimes shows no further symptoms. Occasionally, however, redness and swelling of the scar may occur; oftener there are pains extending from the scar along the nerve paths of the brain.

Symptoms.—The symptoms may be divided into three stages: (1) the prodromal stage; (2) the excited or convulsive stage; and (3) the paralytic stage. When the second stage is the most pronounced, the

disease is called furious or convulsive rabies; when this stage is very short or practically lacking and paralysis begins early, the disease is called dumb or paralytic rabies.

In the dog rabies appears in the two typical forms: the furious and the paralytic. The principal symptoms of each form may be summarized as follows:

Furious Rabies.—Change of behavior, biting (especially at those to whom the animal has been affectionate before), characteristic restlessness and aggressiveness with a tendency to run long distances, loss of appetite for ordinary food with desire to eat unusual things, the animal does not fear water, as the name hydrophobia erroneously implies, but has difficulty in swallowing and runs about attacking all objects in its way, intermitted disturbance of consciousness, paraxysms of fury, peculiar bark or howl, rapid emaciation, paralysis beginning in the hind limbs, and death in three to six days (exceptionally slightly longer) after the beginning of symptoms.

Paralytic Rabies.—Short period of excitation (which may be inconspicuous, the animal fawning upon its master), paralysis of the lower jaw, hoarse bark, appetite and consciousness disturbed, weakness with paralysis spreading in a great majority of cases, and death four to five days after the first symptoms. There may be a number of cases showing transition types between these two forms, but all rabid animals become paralyzed before they die. Death takes place as a rule on the third or fourth day after symptoms have developed, but a few cases have been reported of death occurring after longer intervals.

In Human Beings. Furious Rabies.—The first definite symptoms are difficult and gasping breath with feeling of oppression and difficulty in swallowing, the latter the most characteristic symptom. It is caused by convulsive contraction of the throat muscles, attacks being brought on when attempting to drink or swallow. The convulsive attacks finally become more or less general over the whole body; in certain cases some parts are more affected by reflex excitation than others, as, for instance, there may be slight or no photophobia, while in exceptional cases, more frequently in dogs, the hydrophobia or fear of swallowing is also absent. Most of the special reflexes are increased. Pupils become irregularly contracted and widened until they remain fixed.

Human beings are seldom dangerous to the people about them; they do not make aggressive bites. In their convulsions they may bite things placed between their teeth, but not otherwise. At this time there is an increased flow of saliva, and one should avoid the contact of this with opened wounds. It may be so increased that the patient may try to get rid of it by taking it from the mouth with the hand and throwing it about. As a rule, however, the patient has full possession of his senses between the convulsive attacks until very late in the disease.

The temperature is increased from 38° to 40° C., at first with morning remissions. Just before death it may rise as high as 42.8° C. (In the lower animals the temperature sinks below normal just before death.) The pulse is generally over 100 and is irregular. This stage

lasts from one to four days. Death may occur during a convulsion, but more often there is a paralytic stage, which lasts from two to eighteen hours. The convulsions become less frequent and the patient becomes weaker until there is a complete paralysis. At the beginning of this stage the patient may be able to drink water better than formerly. Death may occur at any time through paralysis of the heart or respiratory center, usually on the third or fourth day.

Paralytic Rabies.—This form occurs seldom in human beings, more frequently in dogs, but not so often as the convulsive form. It is supposed to occur in humans and dogs after a more severe infection. Instead of periods of convulsions, the various muscles simply tremble and become gradually weaker until complete paralysis supervenes. Sometimes paralysis develops very quickly and may be general before death from syncope or asphyxia occurs. This form generally lasts longer than ordinary rabies. Between these two typical forms of rabies there are many different types. In paralytic rabies the average time of death is on the fifth day.

Diagnosis.—The positive diagnosis of rabies can be made only by laboratory methods. While the symptoms above described may be suggestive, they must always be confirmed by the findings in the pathological lesions or by animal tests.

Since 1906, in our routine work in the New York City Health Department Laboratories, we have considered the presence of the Negri bodies in smears made from the fresh brain as diagnostic of rabies, and have made no further tests except in those cases which were used for experimental purposes. In this experimental work, however, we have added many hundred cases to the list of those which had comparative tests, and our former conclusions have been firmly established. In all our work controlled by careful animal inoculations we have never failed to have typical rabies develop in animals inoculated with material showing definitely structured Negri bodies. So far we have not had rabies produced by fresh brains showing no Negri bodies and no suspicious forms; but a few observers have claimed that such material has produced the disease. Decomposing brains may show in smears bodies very similar to these tiny forms; in such cases, therefore, it is difficult to rule out rabies. For this reason, animal tests will probably always have to be made with brains too decomposed to show any formed elements except bacteria, and also in all cases in which only suspicious bodies have been found by microscopical examination, or at least until the technic has been standardized. In any case, however, we may be reasonably certain that when the fresh material examined microscopically is negative, it was not a case of rabies.

Our conclusions regarding the value of the smear method in diagnosis may be expressed as follows:

1. Negri bodies well demonstrated in fresh brains, diagnosis rabies (except 4).

2. Negri bodies not demonstrated in fresh brains, probably not rabies (except 4).

3. Negri bodies not demonstrated in decomposing brains, uncertain.
4. Suspicious bodies in fresh brains, probably rabies.

The diagnosis of rabies by animal experimentation, which consists in placing a small quantity of the suspected material under the dura mater of a rabbit or guinea-pig, is final. But this method requires so much time (on account of the long incubation period of the disease), that it is of no practical value in deciding whether or not the Pasteur treatment should be given. In any doubtful case, however, the evidence furnished by animal experimentation is irrefutable.

Disposal of Dogs Suspected of Rabies.—Should a dog be suspected of rabies it should not be killed (unless absolutely necessary), but securely fastened up by a chain in a kennel or enclosure, where no other animal or person can have access to it. If the dog has rabies paralysis will develop and the animal will die, usually in four or five days. If no paralysis develops, and the dog is alive and well at the end of two weeks, the disease is not rabies, and the animal may be safely released.

If the animal has been killed, the brains should never be blown out, the head should be severed from the body by a sharp instrument (if the body is too large to ship) as near the thorax as possible, packed in ice in a watertight vessel, and forwarded *at once* to the laboratory for examination; care being taken during the operation and handling to protect the hands from infection. The hands and instruments used should later be thoroughly disinfected, and the carcass of the animal burned or deeply buried.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the Disease.*—Clinical symptoms, confirmed by the presence of Negri bodies in the brain of an infected animal, or by animal inoculations with material from the brain of such infected animal.

2. *Isolation.*—None if patient is under adequate medical supervision, and the immediate attendants are warned of possibility of inoculation by human virus.

3. *Immunization*—Preventive vaccination (Pasteur's treatment) after exposure to infection by inoculation.

4. *Quarantine.*—None.

5. *Concurrent disinfection* of saliva of patient and articles soiled therewith.

6. *Terminal Disinfection.*—Thorough cleansing.

II. General Measures.—1. Muzzling of dogs when on public streets or in places to which the public has access, and later quarantine of all dogs coming from other places, where rabies is prevalent.

2. Detention and examination of dogs suspected of having rabies.

3. Immediate antirabic treatment of people bitten by dogs or by other animals suspected or known to have rabies, unless the animal is proved not to be rabid by subsequent observation or by microscopic examination of the brain and cord.

Registration, licensing and taxing, and leashing of dogs are restrictive, not preventive measures. The muzzling of dogs was adopted in

England for a time, and rabies began to decrease. Then owing to false sympathy for the dog, the law was repealed, and rabies at once commenced to increase again. The law was once more enacted and relentlessly enforced for two years, when rabies disappeared entirely. A strict quarantine of six months is now maintained against all dogs in England, but dogs are no longer muzzled. Should the disease become prevalent, the law will again be enforced. Rabies is unknown in Australia, having been kept out by the enforcement of effective quarantine measures. In Norway, Sweden and Denmark the disease has been absent for fifty years, owing to the wise provision of similar legislative control of dogs. New York City is now trying to enforce such laws. Other countries and cities can do the same. Were all dogs under strict legislative control, and the compulsory wearing of muzzles rigidly enforced for a period of two years, with later quarantine regulations, as above illustrated, hydrophobia would be stamped out; and in this way only can the disease be eradicated.

There are facts which have been amply demonstrated by experience, but until the necessary drastic measures are taken to eradicate this wholly preventable infection, palliation methods of treatment must be adopted to reduce its mortality if not its prevalence.

Local Treatment.—In wounds caused by the bite of an animal, when rabies is suspected, and the Pasteur preventive treatment cannot be applied, great benefit may be derived from the correct use of cauterization with fuming or strong nitric acid. This is effective twelve to twenty-four hours after the bite. Even in cases when the Pasteur treatment can be given, an *early* cauterization will be of much assistance as a routine practice; for the Pasteur treatment is often delayed several days for obvious reasons and thus does not always protect. In the case of slight wounds all the treatment probably indicated may be thorough cauterization with nitric acid, applied with a glass rod, within twelve hours from the time of infection. Our experience in dealing with persons bitten by rabid animals goes to show that physicians have not sufficiently appreciated the value of thorough cauterization of the infected wound. In the absence of nitric acid, the actual cautery may be used. Antiseptics are not to be relied on. Unless absolutely certain that the animal is not mad, all wounds produced by the bite of an animal should be cauterized.

Pasteur's Method of Preventive Vaccination.—The old treatment of rabies consisted simply in encouraging bleeding from the wound, or in first excising the wound and then encouraging bleeding by means of ligatures, warm bathing, etc.; the raw surface was then freely cauterized with caustic potash, nitric acid, or the actual cautery. It is doubtful whether the disease ever manifested itself after such heroic treatment, if the wound were small and the treatment was begun soon after the bite; but when the wounds were numerous or extensive, the mortality was still high. As it was often impossible to apply cauterization to the wound rapidly or deeply enough to insure complete destruction of the virus, Pasteur and others were led to study the dis-

ease experimentally in animals with the hope of finding some means of immunization or even cure; these investigations finally resulted in the discovery of methods of preventive inoculation applicable to man.

Pasteur's treatment is based upon the fact that rabic virus may be weakened or intensified under certain conditions. He first observed that the tissues and fluids taken from rabid animals varied considerably in their virulence. Then he showed that the virus may be intensified by successive passages through certain animals (rabbits, guinea-pigs), and weakened in passing through others (monkeys). If successive inoculations be made into rabbits with virus, either from the dog or the monkey, the virulence may be so exalted beyond that of the virus taken from a street dog, that at the end of the fiftieth passage the incubation period may be reduced to about six or seven days, when it remains fixed. This "fixed virus" was used by Pasteur, and others later, in his preventive treatment because the dose could be more definitely regulated by subsequent attenuation or dilution.

In the original method employed by Pasteur, a series of spinal cords from rabbits dead from "fixed virus" infection are cut into segments and suspended in sterile glass flasks plugged with cotton stoppers and containing a quantity of some hygroscopic material, such as caustic potash; these are kept at a temperature of about 22° C. The cord when taken out at the end of the first twenty-four hours is found to be about as active as the fresh untreated cord; that removed at the end of forty-eight hours is slightly less active; and the diminution in virulence, though gradual, progresses regularly and surely until, at the end of the eighth day the virus is inactive. Pasteur began his treatment with an emulsion of the cord kept until the fourteenth day. A certain quantity of this was injected into the animal that had been bitten; this was followed by an injection of an emulsion of a twelve-day cord, and so on, until the animal had been injected with a perfectly fresh, and therefore, extremely active cord, corresponding to the fixed virus. Animals treated in this way were found by Pasteur to be absolutely protected, even against subdural inoculation with considerable quantities of the most virulent virus; and thus Pasteur's protection vaccination became an accomplished fact. A series of experiments were carried out which led to the discovery that if the process of inoculation be begun within five days of the bite in animals, in which the incubation period was at least fourteen days, almost every animal bitten can be saved, and that even if the treatment be commenced at a longer interval after the bite a certain proportion of recoveries can be obtained. Thus the application of this method of treatment to the human subject was not tried until it had been proved in animals that such protection was possible, and that it would last for at least one year and perhaps longer.

The chance of success in the human subject appears to be even greater than in the dog or rabbit. Man's period of incubation is comparatively prolonged. Thus there is an opportunity of obtaining immunity by beginning the process of inoculation soon after the bite has been inflicted, the protection being complete before the incubation period has passed.

Pasteur's original method has undergone modification in three general directions: (1) lengthening or shortening the period of treatment; (2) starting the inoculation with a less attenuated cord; (3) increasing or decreasing the amount given at each injection. The method of drying the cord, however, has remained comparatively little changed from that employed by Pasteur.

An *intensive method* of treatment is now commonly used in preference to Pasteur's original method. This method is adopted in the New York Health Department Laboratories, the Hygienic Laboratory, Public Health Service, at Washington, D. C., and other places. In this method the first inoculation is made with the 8-day cord and by the eighth day a 1-day cord is inoculated. The treatment lasts twenty-one days. Each dose contains ½ cm. of the indicated cord emulsified in 3 c.c. of normal salt solution, and 2½ c.c. of this emulsion is inoculated.

In other than very severe cases a 2-day cord is used for the first inoculation, instead of a 1-day cord. In cases with very slight wounds, which have begun treatment immediately, the inoculations are carried on only as far as the fifteenth day.

Many Pasteur institutes now use a modified treatment starting with an 8-day or fresher cord, instead of the 14-day old cord. But at l'Institut Pasteur in Paris, and some others, the original schema is still employed, as first proposed by Pasteur.

Results.—On the whole the results of protective inoculations against rabies are marked, when compared with the mortality statistics, after bites from animals suffering from hydrophobia, of those given after any other method of treatment; but these statistics not having been uniformly kept, it is difficult to analyze their value.

Immunity appears two weeks after the treatment and in human beings lasts a variable time, which has not been accurately determined. That it may not last longer than fourteen months was shown by a case under our observation, in which an apparent reinfection occurred at that time.

Effects of Treatment.—There is only slight local discomfort, as a rule. During the second week an erythema often appears about the point of inoculation but soon disappears. Occasionally, ever since the introduction of the treatment non-fatal affections of the nervous system have been reported, which occurred during or short time after the treatment. These affections have varied in degree from a slight neuritis through paraplegia to paralysis of different parts of the body. Very rarely the paralyses have been severe and the patient died. It should be noted that cases of true paralytic rabies may occur within the period required for the establishment of immunity by the treatment, and these must be differentiated from paralysis occurring as a result of treatment.

Treatment by Mail.—The New York City Health Department was the first to send out treatment by mail to physicians for their own patients. Full directions accompany the mailing cases. One-quarter per cent. carbolic acid is added to the emulsion prepared as described

for the first three days' treatment; 20 per cent. glycerin is added to all other emulsions. These are added as preservatives and are therefore omitted when the virus is administered to patients at the laboratory. The results from the treatment sent in this way seem to be equally as good as those from the treatment given in the laboratory.

Antirabic serum (prepared by Marie and others) has been used to some extent in the treatment of rabies; but though certain advantages have been claimed for this method over the original Pasteur treatment, it has not come into general use.

PLAGUE.

.(Bubonic, Septicemic, Pneumonic)

An acute, fatal, specific, epidemic fever characterized by the formation of boils, carbuncles, buboes and petechiæ.

This disease, which in the Middle Ages became such a terrible scourge that it was known as the "black death," is still one of the most dreaded of the great epidemic infections. It has, however, been confined principally to Asia. Both in China and India there have been outbreaks of great severity in the last twenty years, and even in this hemisphere in certain parts of South America and the United States, occasional cases have occurred. Judging from the readiness with which it has been checked and limited wherever it made its appearance in this country, there is very little risk that the plague will ever assume again its former devastating power among civilized nations.

Three types of the disease are now recognized: the bubonic, pneumonic and septicemic forms. One of the most fatal forms of infection is that of the lungs. Pneumonic cases are not alone serious in themselves, but they readily spread the infection.

There is considerable immunity produced in this disease. Like typhoid infection, a single attack of the plague protects, with rare exceptions, from a second infection.

Artificial immunity, active or passive, may be acquired in various ways. The active immunity produced by the vaccination of cultures (Haffkine's prophylactic) protects partially for six months or more. Those that develop plague after vaccination have on the average a milder form. The passive immunity produced by the injection of antiplague serum lasts only about three weeks.

Infectious Agent.—The infectious agent is the bacillus pestis.

Source of Infection.—The source of infection is the blood of infected persons and animals and sputum of human cases of plague pneumonia.

Mode of Transmission.—The mode of transmission is direct in the pneumonic form. In other forms the disease is generally transmitted by the bites of infected fleas which have fed on sick rats, by which the disease is carried from rats to man, also by fleas from other rodents. Rats are not infected directly by other rats but by means of their infected fleas. Bed-bugs may transmit the infection.

Incubation Period.—The incubation period is commonly from three to seven days, although occasionally prolonged to eight or even fourteen days.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by the clinical symptoms, confirmed by bacteriological examination of blood, pus from glandular lesions, or sputum. Climatic bubo and venereal buboes are the diseases most apt to be mistaken for plague infection.

2. *Isolation* of the patient in a hospital if practicable; if not, in a screened room which is free from vermin. In plague pneumonia, personal prophylaxis, to avoid droplet infection, must be carried out by persons who come in contact with the sick. Masks or veils of cheesecloth should be worn as protective measures.

3. *Immunization.*—Passive immunization of known exposed contacts; active immunization of those who may be exposed.

4. *Quarantine* of contacts for seven days.

5. *Concurrent disinfection* of all discharges and articles freshly soiled therewith.

At termination use thorough cleansing and disinfection.

II. General Measures.—1. *Extermination of rats* and vermin by use of known methods for their destruction; destruction of rats on ships arriving from infected ports; examination of rats, ground squirrels, etc., in areas where the infection persists, for evidence of endemic or epidemic prevalence of the disease among them.

2. *Supervision of autopsies* of all deaths during epidemics.

3. *Cremation*, or burial in quicklime, of those dying of this disease.

CLIMATIC BUBO.

This is a disease of unknown etiology occurring in the West Indies and many tropical and subtropical countries. The inguinal glands are enlarged. The swelling is associated with moderate pain and fever. The duration of the disease is from two weeks to several months. Sailors and stokers are apt to contract it. The prognosis is always good. Relapses may occur. No methods of prevention are known.

ACTINOMYCOSIS.

This disease occurs endemically in cattle; it is more rare among swine and horses. Many cases have in recent years been reported in man. The disease is rarely communicated from one animal to another and no case is known of a direct history of human contagion.

As a rule, the disease is not accompanied by fever. In cattle the disease is usually situated in some portion of the head, especially in the jaw, tongue, or tonsils, hence called "lumpy jaw," "wooden tongue,"

etc. Primary lung, intestinal and skin lesions are not infrequent. These local lesions sometimes scatter and produce a general infection and the udder may be involved.

Infectious Agent.—The infecting agent is the Actinomyces bovis.

Source of Infection.—The source of infection is the nasal and bowel discharges, and the infected material from lesions in human and animal cases of the disease. Uncooked meat from infected animals may serve as a source of infection.

Mode of Transmission.—The mode of transmission is by contact with the discharges or with articles freshly soiled with discharges from animal or human cases.

Incubation Period.—The incubation period is unknown.

Period of Communicability.—The period of communicability is as long as open lesions remain, as proved by the presence of infective agent on microscopic or cultural tests.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by the clinical symptoms, confirmed by microscopic examination of discharges from lesions.

2. *Isolation.*—None, provided the patient is under adequate medical supervision.

3. *Immunization.*—None.

4. *Quarantine.*—None.

5. *Concurrent disinfection* of discharges from lesions and articles soiled therewith.

6. *Terminal disinfection* by thorough cleansing.

II. General Measures.—1. Inspection of meat, with condemnation of carcasses, or infected parts of carcasses, of infected animals.

2. Destruction of known animal sources of infection.

GLANDERS.

Glanders.—An infectious disease of the horse, communicated occasionally to man. In the horse it is characterized by the formation of nodules, chiefly in the nostrils (glanders) and beneath the skin (farcy).

Glanders is communicated to man by contact with affected animals, usually by inoculation on an abraded surface of the skin. The contagion may also be received on the mucous membrane. Infection has occasionally been produced in bacteriologic laboratories. In man, as in horses, an acute and chronic form of glanders may be recognized. It is transmissible also from man to man. Washerwomen have been infected from the clothes of a patient. Glanders is by no means an uncommon disease among horses, sometimes taking a mild course and remaining latent for a considerable time. Horses apparently healthy, therefore, may possibly spread the disease through the public drinking troughs and blacksmith shops.

Infectious Agent.—The infectious agent is the Bacillus mallei.

Source of Infection.—The source of infection is the discharges from open lesions of mucous membranes, or of the skin of human or equine

cases of the disease (*i. e.*, pus and mucus from the nose, throat, and bowel discharges from infected man and horse).

Mode of Transmission.—The mode of transmission is by contact with a case or with articles freshly soiled by discharges from a human or equine case.

Incubation Period.—The incubation period is unknown.

Period of Communicability.—The period of communicability is until bacilli disappear from discharges or until lesions have healed.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by specific biological reactions, such as the complement-fixation test, the mallein test, the agglutination test; or by non-specific reactions, such as the Straus reaction, if confirmed by culture, or by identification of the Bacillus mallei, or by autopsy of doubtful cases.

2. *Isolation* of human cases at home or in the hospital; for infected horses destruction rather than isolation is advised.

3. *Immunization.*—None of established value or generally accepted.

4. *Quarantine* of all horses in an infected stable until all have been tested by specific reaction, and the removal of infected horses and terminal disinfection of the stable have been accomplished.

5. *Concurrent disinfection* of discharges from human cases and articles soiled therewith.

6. *Terminal disinfection* of stables and contents in horse cases of the disease.

II. General Measures.—1. The abolition of the common drinking trough for horses.

2. Sanitary supervision of stables and blacksmith shops.

ANTHRAX.

Anthrax (Malignant Pustule—Woolsorters' Disease).—An acute infectious disease which is very prevalent among animals, particularly sheep and cattle due to the Bacillus anthracis. It occurs in man sporadically as a result of accidental infection.

This disease is the most widespread of all infectious disorders. It is much more common in Europe and in Asia than in America. The ravages among herds of cattle in Russia and Siberia, and among sheep in certain parts of France, Hungary, Germany, Persia and India exceed any other animal plague. In infected districts the greatest losses are incurred during the hot months of summer. Cold-blooded animals and birds as well as swine and dogs, are refractory. In this country the disease is rather rare.

In man it occurs as the result of infection, either through the skin, the intestines, or in rare instances through the lungs. It is found in persons whose occupations bring them into contact with animals or animal products, as stablemen, shepherds, tanners, butchers, and those who work in wool and hair. Two forms of the disease have been described—the external anthrax or malignant pustule, and the internal

anthrax, of which there are intestinal and pulmonary forms, the latter being known as "woolsorters' disease." The malignant forms, particularly the intestinal or pulmonary cases, are usually fatal.

Source of Infection.—The source of infection is the hair, hides, flesh and feces of infected animals. Shaving brushes have been shown to be frequently infected.

Mode of Transmission.—The mode of transmission is by inoculation, as by accidental wound or scratch, inhalation of spores of the infectious agent and ingestion of insufficiently cooked infected meat.

Incubation Period.—The incubation period is within seven days.

Period of Communicability.—The period of communicability is during the febrile stage of the disease and until lesions have ceased discharging. Infected hair and hides of infected animals may communicate the disease for many months after slaughter of the animal, and after the curing of hide, fur or hair unless disinfected.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by the clinical symptoms, confirmed by bacteriological examination.

2. *Isolation* of the infected individual until the lesions have healed.

3. *Immunization.*—None.

4. *Concurrent disinfection* of the discharges from lesions and articles soiled therewith.

II. General Measures.—1. Animals ill with a disease presumably anthrax should be placed immediately in the care of a veterinary surgeon and isolated.

2. *Immunization* of exposed animals under direction of Federal or State Department of Agriculture.[1]

3. *Postmortem examinations* should be made only by a veterinary surgeon, or in the presence of one.

4. *Milk from an infected animal* should not be used.

5. Shaving and other brushes should only be made from uninfected or disinfected materials.

6. *Control and disinfection* of effluent and trade wastes and of areas of land polluted by such effluent and wastes from factories or premises when spore-infected hides or other infected hide and hair products are known to have worked up into manufactured articles.

7. *A physician should be constantly employed* by every company handling raw hides, or such companies should operate under the direct supervision of a medical representative of the health department.

8. *Every employee* handling raw hides, hair or bristles who has an abrasion of the skin should immediately report to a physician.

9. *Special instruction* should be given to all employees handling raw hides in regard to the necessity of personal cleanliness.

10. *Tanneries and woollen mills* should be provided with proper ventilating apparatus so that dust can be promptly removed.

11. *Disinfection of hair,* wool, and bristles of animals originating in known infected centers before they are used or assorted.

[1] The method of producing immunity to anthrax in cattle and sheep through the injection of attenuated cultures, as suggested by Pasteur, is not applicable to man.

12. *The sale of hides* from an animal infected with anthrax should be prohibited. A violation of this regulation should be immediately reported to the State Commissioner of Agriculture, by telegram, stating the time, place, and purchaser to whom the hide was sold. The report should also be sent to the person purchasing the hide. Carcasses should be disposed of under the supervision of the State Department of Agriculture. The inspection and disinfection of imported hides are under the supervision of the United States Bureau of Animal Industry. In the event that infection is introduced the State Agricultural authorities have jurisdiction over infected animals and the local or State health authorities have jurisdiction over infected persons.

ROCKY MOUNTAIN SPOTTED FEVER.

An acute infectious disease characterized by fever and a more or less hemorrhagic eruption.

This disease, also called tick and spotted fever, occurs chiefly in the Bitter Root Valley of Montana, and in the neighboring States of Idaho and Wyoming, also in Washington and California. The symptoms resemble those of typhus fever. Ticks of the genus *Dermacentor* probably carry the infection. These ticks either in the miniature or adult stage have been found upon 20 species of 500 mammals examined in and around Bitter Root Valley.

Infectious Agent.—The infectious agent is unknown.

Source of Infection.—The source of infection is the blood of infected animals, and infected ticks (Dermacentor species).

Mode of Transmission.—The mode of transmission is by the bites of infected ticks.

Incubation Period.—The incubation period is from three to ten days, usually seven days.

Period of Communicability.—The period of communicability has not been definitely determined, probably during the febrile stage of the disease.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by the clinical symptoms in areas where the disease is known to be endemic.

2. *Isolation.*—None other than care exercised to protect patients from tick bites when in endemic areas.

3. *Immunization.*—None.

4. *Quarantine.*—None.

5. *Concurrent Disinfection.*—None. All ticks on the patient should be destroyed.

6. *Terminal Disinfection.*—None.

II. General Measures.—1. Personal prophylaxis of persons entering the infected zones during the season of ticks by wearing tick-proof clothing and careful daily search of the body for ticks which may have attached themselves.

2. The destruction of ticks by clearing and burning vegetation on the land in infected zones.

3. The destruction of ticks on domestic animals by dipping, and the pasturing of sheep on tick-infected areas where the disease is prevalent, with the object of diminishing the number of ticks.

4. The destruction of small mammalian hosts as ground squirrels, chipmunks, etc.

DENGUE.

Dengue ("Break-bone Fever").—An acute infectious disease of tropical and subtropical countries, characterized by febrile paroxysms, pains in the joints and muscles, and sometimes a skin eruption.

This disease occurs in widespread epidemics often preceding or coincident with those of yellow fever, which adds to its importance. It attacks all races equally, and although it is a painful affection and sometimes leaves the body in a weakened condition for a long time, it is never fatal.

Infectious Agent.—The infectious agent is unknown.

Source of Infection.—The source of infection is the blood of infected persons.

Mode of Transmission.—The mode of transmission is by the bite of infected mosquitoes, probably the *Culex fatigans.*

Incubation Period.—The incubation period is from four to five days.

Period of Communicability.—The period of communicability is during the febrile stage of the disease.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by the clinical symptoms.

2. *Isolation* of the patient in a screened room.

3. *Immunization.*—None.

4. *Quarantine.*—None.

5. *Concurrent Disinfection.*—None.

6. *Terminal Disinfection.*—None. Upon the termination of the disease, fumigation of the room and house, to destroy mosquitoes.

II. General Measures.—These include measures directed toward elimination of mosquitoes, and screening of rooms.

INFECTIOUS CUTANEOUS DISEASES CAUSED BY FUNGI.

Tinea circinata or **Ringworm** of the body or hairless parts of the skin, and *Tinea tonsurans, Tinea barbæ* or *Tinea sycosis,* ringworm of the hairy parts of the skin, are two species of the *trichophyton.*

Ringworm of the skin yields readily to treatment, but ringworm of the scalp is extremely chronic. When the disease attacks the scalp the hair falls or breaks off near the scalp, leaving areas the size of a dime or dollar nearly bald. The scalp in these areas is usually dry and somewhat scaly, but may be swollen and crusty. The disease spreads at the circumference of the area and new areas are produced by scratching, etc.

Tinea favosa or **Favus** is a cutaneous disease somewhat allied to ringworm, though less contagious. It is caused by a fungus, the *Achorion schoenleinii.*

In this disease abundant umbilicated crusts of yellowish color are present, when the process is active, which grow into a mass resembling a honeycomb. The disease is communicated by contagion, the fungus being often derived from animals, especially cats, mice, rabbits and fowls; dogs are also subject to it. It grows more slowly than the ringworm fungus, and therefore is not so easily transmitted. Want of cleanliness is a predisposing factor. The fungus seems to find more favorable soil for its development in the skin of persons in delicate health, especially from phthisis, than in others. The disease shows a marked preference for the scalp, but no part of the skin is exempt. The roots of the hair are killed by the parasite, so that loss of hair from the disease is permanent , a scar remaining when the condition is cured.

Tinea versicolor or **Pityriasis versicolor** is another parasitic skin disease. It is caused by the fungus, *Microsporon furfur.*

This disease by preference attacks the chest, abdomen, back and axillæ, less frequently the neck and arms, while exceptionally it attacks also the head and face. The growth shows itself as scattered spots, varying in color from cream-coffee to reddish brown. The infection, though slightly contagious, is one of the most common of skin diseases. Persons with a tender skin and a disposition to perspire freely are particularly affected. Women are more frequently attacked than men, while children and old persons are rarely affected. The source of the affection is unknown, as absence of contagion has been repeatedly demonstrated.

Infectious Agent.—The infectious agent is various forms of fungi:

1. Tinea circinata and other forms of ringworm—trichophyton.
2. Tinea favora (favus)—Achorion schoenleinii.
3. Tinea versicolor—Microsporon furfur.

Source of Infection.—The source of infection are lesions of the skin and scalp.

Mode of Transmission.—The mode of transmission is by direct contact with the patient and indirectly through toilet articles.

Incubation Period.—The incubation period is unknown.

Period of Communicability.—The period of communicability is until the skin and scalp lesions are all healed.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by its clinical symptoms, confirmed by microscopic examination of the lesions (crusts).

2. *Isolation.*—Exclusion of the patient from school and other public places until the lesions are healed.

3. *Immunization.*—None.

4. *Quarantine.*—None.

5. *Concurrent disinfection* of the toilet articles of the patient.

6. *Terminal Disinfection.*—None.

II. General Measures.—1. *Elimination of common utensils,* such as hair brushes and combs, etc.

2. Provision for adequate and intensive treatment and care of cases of infectious skin diseases at hospitals and dispensaries, to alleviate the period of the infectivity of the patients.

TRICHINOSIS.

An infectious febrile disease caused by the Trichinella spiralis, a round worm which passes its entire life cycle in man, rat or hog.

The incidence of this disease in swine varies much in different countries according to the thoroughness with which systematic microscopic examination of swine flesh is made. About 1 or 2 per cent. of American swine and a larger percentage of American rats are infected. The normal or common host of the parasite is the rat, which becomes infected in slaughter houses and butcher shops. Hogs get the disease by eating rats, through feces or directly from infected offal. Man receives the infection by eating the uncooked or insufficiently cooked, flesh of trichinous hogs.

The Trichinella spiralis in its adult condition lives in the small intestines. The disease is produced by the embryos, which pass from the intestines and reach the voluntary muscles, where they finally become encysted—muscle trichinæ. It is in the migration of the embryos that the group of symptoms known as trichinosis is produced.

Not all persons who eat trichinous flesh have the disease. When a limited number of the parasites are eaten only a few embryos pass to the muscles and may cause no symptoms. Well characterized cases in man present two stages: (1) gastro-intestinal, and (2) general infection. In the second stage the symptoms are fever, intense pain in the muscles, edema and leukocytosis. The average mortality of the disease is about half that of typhoid fever, in some epidemics rising to 16 or even 30 per cent.

Infectious Agent.—The infectious agent is the Trichinella spiralis.

Source of Infection.—The source of infection is uncooked or insufficiently cooked meat of infected hogs.

Mode of Transmission.—The mode of transmission is the consumption of undercooked infected pork products.

Incubation Period.—The incubation period is variable, usually about one week.

Period of Communicability.—The disease is not transmitted by the human host.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by the clinical symptoms, confirmed by microscopic examination of muscle tissue containing trichinæ.

2. *Isolation.*—None.

3. *Immunization.*—None.

4. *Quarantine.*—None.

5. *Concurrent Disinfection.*—Sanitary disposal of the feces of the patient.

6. *Terminal Disinfection.*—None.

II. General Measures.—1. Inspection of pork products for the detection of trichinosis.

2. Thorough cooking of all pork products at a temperature of 160° F. or over.

3. Persistent warfare against rats in slaughter houses, butcher shops, markets and places where hogs are kept.

4. Contaminated feces and offal must not be fed to hogs.

ANCHYLOSTOMIASIS.

Hookworm disease is endemic in tropical and subtropical countries encircling the globe, but diminishing toward the temperate regions. It does not occur in the colder latitudes, except in mines, especially those of Wales, Germany, Netherlands, Belgium, France and Spain. The Egyptian chlorosis, brickmakers' anemia, tunnel anemia, miners' cachexia and mountain anemia are due to this cause. Hookworm disease is very common in American Samoa and in Porto Rico, also in Southern China, India and Egypt. In this continent a large number of the population among the poorer classes are infected in the Southern States from the Potomac to the Mississippi and along the Atlantic Seaboard and the Gulf States.

There is no acquired immunity to the disease, although there is a distinct racial immunity, as shown in the negroes and Filipinos, who are often infected but have comparatively slight symptoms. It is thought that the negro is the original source, as he is the chief reservoir of the infection in this country, having brought it from Africa, where he had the disease so many generations ago that he has become immune.

Hookworm disease is much more serious in its secondary results than in its primary effects; it lowers the resistance and greatly increases the liability to other infections, especially tuberculosis. Its prevention, therefore, presents a problem of considerable importance from a public health standpoint.

Almost all mammalian animals have hookworms, but each host has a species peculiar to itself and specific for each. Thus the hookworm of the dog differs from that of man and other mammalian hosts and will not infect them.

There are two species found in man, but the vast majority of cases of hookworm disease in man in the United States are due to the Necator americanus. In 90 per cent. or more of cases the infection is communicated through the skin at any point, but the embryos usually enter the soft skin between the toes of persons who go barefoot on polluted soil. The embryos may also occasionally be taken in by the mouth in drinking water or solid food, or from contaminated objects, such as dirty fingers.

The hookworm larva passes through five molts, two of which occur during its free-living stage in the outer world and three during its residence in the host. With each stage it approaches nearer to the appearance and structure of the adult worm. The larva pierces the

skin and passes by a circuitous route to the intestinal tract. In its passage through the skin (as between the toes) it produces an inflammatory reaction known as ground-itch. The infection leaves the body exclusively in the feces, which contain the eggs of the parasite.

Infectious Agent.—The infectious agent is the achylostoma (Necator americanus).

Source of Infection.—The source of infection is the feces of infected persons. Infection generally takes place through the skin, occasionally by the mouth.

Mode of Transmission.—The mode of transmission is by drinking water containing larvæ, by eating soiled food, by hand to mouth tranmission of the eggs or larvæ from objects soiled with infected discharges. The larval forms pierce the skin and passing through the lymphatics to the vena cava and the right heart, thence in the blood stream to the lungs, they pierce the capillary walls and pass into the alveoli. Then they pass up the bronchi and trachea to the throat, whence they are swallowed and finally lodge in the small intestine.

Incubation Period.—The incubation period is from seven to ten weeks.

Period of Communicability.—The period of communicability is as long as the parasite or its ova are found in the bowel discharges of an infected individual. Contaminated soil remains infective for five months in the absence of freezing.

Methods of Control.—I. The Infected Individual and his Environment.—1. *Recognition of the disease* by microscopic examination of bowel discharges.

2. *Concurrent Disinfection.*—Sanitary disposal of bowel discharges.

3. *Treatment.*—Appropriate treatment (by the use of thymol, beta-naphthol or other anthelmintic) of infected individuals to rid the intestinal canal of the parasite and its ova.

II. General Measures.—1. *Education as to the dangers* of soil pollution.

2. *Prevention of soil pollution* by installation of sanitary disposal of human discharges.

3. *Personal prophylaxis* by cleanliness and the wearing of shoes.

CHAPTER IV.

PRACTICAL USE OF DISINFECTANTS.

By WILLIAM H. PARK, M.D.

Many substances, when brought in contact with bacteria, combine with their cell substance and destroy the life of the bacteria. While in the vegetative stage bacteria are much more easily killed than when in the spore form, and their life processes are inhibited by substances less deleterious than those required to destroy them.

Bacteria, both in the vegetative and in the spore form, differ among themselves considerably in their resistance to the poisonous effects of chemicals. The reason for this is not wholly clear, but it is connected with the structure and chemical nature of their cell substance.

Chemicals in sufficient amount to destroy life are more poisonous at temperatures suitable for the best growth of bacteria than at lower temperatures, and act more quickly upon bacteria when they are suspended in fluids singly than when in clumps, and in pure water rather than in solutions containing organic matter. The increased energy of disinfectants at higher temperatures indicates in itself that a true chemical reaction takes place. In estimating the extent of the destructive or inhibitive action of chemicals the following degrees are usually distinguished:

1. The growth is not permanently interfered with, but the pathogenic and zymogenic functions of the organism are diminished—*attenuation*. This loss of function is usually quickly recovered.

2. The organisms are not able to multiply, but they are not destroyed —*antiseptic* action. When transferred to a suitable culture fluid free of the disinfectant these bacteria are capable of reproduction.

3. The vegetative development of the organisms is destroyed, but not the spores—incomplete or complete sterilization or disinfection, according as to whether spores are present in the organisms exposed and as to whether these spores are capable of causing infection.

4. Vegetative and spore forms are destroyed. This is complete *sterilization* or *disinfection*.[1]

A deodorant destroys or neutralizes unpleasant odors. Many deodorants have no disinfecting power. Fumigation is the use of fumes or gases, driven off by heat, or other means. Some of these gases destroy bacteria, others, vermin and insects. Many are very poisonous to the higher forms of life. Under ordinary conditions gases have great difficulty in penetrating substances. A moderately high temperature aids penetration.

[1] Disinfection strictly defined is the destruction of all organisms and their products which are capable of producing disease. Sterilization is the destruction of all saprophytic as well as parasitic bacteria. It is not necessary in most cases to require disinfectants to be capable of sterilizing infected materials containing spores, for there are but few varieties of pathogenic bacteria which produce spores.

Insecticides. — Gases which act on insects are called insecticides. Some act by suffocation, some as general tissue poisons and some especially on the nervous system.

The methods employed for the determination of the germicidal action of chemical agents on bacteria are, briefly, as follows:

If it is desired to determine the minimum concentration of the chemical substance required to produce complete inhibition of growth we proceed thus: A 10 per cent. solution of the disinfectant is prepared and 1 c.c., 0.5 c.c., 0.3 c.c., etc., of this is added to 10 c.c. of liquefied gelatin, agar, or bouillon, or, more accurately 10 c.c. minus the amount of solution added, in so many tubes. The tubes then contain 1 per cent., 0.5 per cent., 0.3 per cent., and 0.1 per cent. of the disinfectant. The fluid medium in the tubes is then inoculated with a platinum loopful of the test bacterium. The melted agar and gelatin may be simply shaken and allowed to remain in the tubes, and watched for any growth which takes place, or the contents of the tubes may be poured into Petri dishes, where the development or lack of development of colonies and the number can be observed. If no growth occurs in any of the dilutions, lower dilutions are tested. Bacteria that have been previously injured in any way will be inhibited by much weaker solutions of chemicals than will vigorous cells. The same test can be made with material containing only spores.

If it is desired to determine the degree of concentration required for the destruction of vegetative development, the organism to be used is cultivated in bouillon, and into each of a series of tubes is placed a definite amount of diluted culture from which all clumps of bacteria have been filtered; to these a definite amount of watery solution of different percentages of the disinfectant is added. At intervals of one, five, ten, fifteen, and thirty minutes, one hour, and so on a small platinum loopful of the mixture is taken from each tube and inoculated into 10 c.c. of fluid agar or gelatin, from which plate cultures are made. Whenever it is probable that the antiseptic power of the disinfectant approaches somewhat the germicidal, it is necessary to inoculate a second series of tubes from the first so as to decrease still further the amount of antiseptic carried over. The results obtained are signified as follows: x per cent. of the disinfectant in watery solution and at y temperature kills the organism in twenty minutes, z per cent. at the same temperature kills in one minute, and so on. If there be any doubt whether the trace of the disinfectant carried over with the platinum loops may have rendered the gelatin unsuitable for growth, thus falsifying results, control cultures, if extreme accuracy is desired, should be made by adding bacteria which have been somewhat enfeebled by slight contact with the disinfectant to fluid to which a similar trace of the disinfectant has been added. If the strength of the disinfectant is to be tested for different substances it must be tested in these substances or their equivalent, and not in water.

The disinfectant to be examined should always be dissolved in an inert fluid, such as water; if on account of its being insoluble in water it is necessary to use another solvent, control experiments may be required to determine its action on the organism. Sometimes, as in the case of corrosive sublimate, the chemical unites with the cell substance to form

an unstable compound, which inhibits the growth of the organism for a time before destroying it. If this compound is not broken up in the media it will probably not be in the body. In some tests it is of interest to break up this union and note then whether the organism is alive or dead. With corrosive sublimate the bacteria probably die within thirty minutes after the union occurs.

In the above determinations the absolute strength of the disinfectant required is considerably less when culture media poor in albumin are employed than when the opposite is the case Cholera spirilla grown in bouillon containing no peptone or only 0.5 per cent. of peptone are destroyed in half an hour by 0.1 per cent. of hydrochloric acid; grown in 2 per cent. peptone bouillon, their vitality is destroyed in the same time on the addition of 0.4 per cent. HCl. In any case the organisms to be tested should all be treated in exactly the same way and the results accompanied by a statement of the conditions under which the tests were made. It is becoming the custom to state the power of a disinfectant in terms of comparison with pure carbolic acid. A substance which had the same destructive power in a 1 to 1000 solution as carbolic acid in a 1 to 100 solution would be rated as of a strength ten times that of carbolic acid.

The following table gives the results and methods used in an actual experiment to test the effect of blood serum upon the disinfecting action of bichloride of mercury and carbolic acid upon bacteria.

TEST FOR THE DIFFERENCE OF EFFECT OF BICHLORIDE OF MERCURY AND CARBOLIC ACID SOLUTION ON TYPHOID BACILLI IN SERUM AND IN BOUILLON.

Time.	1′	3′	5′	10′	20′	30′	45′	1 hr.	1½ hrs.	2 hrs.	Strength of solution.
A. serum . . 2.5 c.c. $HgCl_2$ sol. 1:1000 2.5 c.c. Typhoid broth culture	+	+	+	−	−	−	−	−	−	−	Equals 1:2000 bichloride.
B. bouillon . 2.5 c.c. $HgCl_2$ sol. 1:1000 2.5 c.c. Typhoid broth culture	−	−	−	−	−	−	−	−	−	−	Same.
C. serum . . 2.5 c.c. Carbolic sol. 5% 2.5 c.c. Typhoid broth culture	+	+	−	−	−	−	−	−	−	−	Equals 2½% carbolic acid.
D. bouillon . 2.5 c.c. Carbolic sol. 5% 2.5 c.c. Typhoid broth culture	+	−	−	−	−	−	−	−	−	−	Same.

− Indicates total destruction of bacteria with no growth in media.
+ Indicates lack of destruction of bacteria with growth in media.

THE STANDARDIZATION OF DISINFECTANTS.

Rideal and Walker were the first to urge a useful method for standardizing disinfectants.

In carrying out the test the various factors must be carefully controlled, thus: *Time:* this should be constant, the strength of the disinfectant being the variant. *Test organisms:* a standard culture of the typhoid bacillus (Hopkins' strain) is used to avoid any variations

due to the different degrees of resistance of various strains. The culture should be subinoculated three days before used. *Medium:* a standard meat-extract broth 1.5 per cent. acid to phenolphthalein; 10 c.c. to a tube is employed. *Temperature:* this test is done at 20° C. This is important, as the germicidal activity increases with the temperature. *Constant amount of culture used:* 0.1 c.c. of the twenty-four-hour broth culture is added to 5 c.c. of the disinfectant solution. This is more accurate than the drop method. *Amount inoculated:* it is essential that the same amount be inoculated from each dilution. Platinum loops made of 23 United States gauge wire, the loops being 4 mm. in diameter are employed. Several are used, being left on a rack after sterilization so as to be cold when needed. The loop is bent at an angle of 45° to the shank.

The actual test is carried out as follows: A 5 per cent. carbolic solution (phenol C. P.), is prepared and standardized by bromine titration. From this freshly prepared 1 to 90 to 1 to 100 and 1 to 110 dilutions are made as needed. The necessary dilutions of germicide are then prepared. Wide jumps in the dilutions are made in the first test and then narrowed as the limits of the disinfectant are determined.

Five test-tubes are arranged in a row in a water-bath at 20° C., and the solutions added in 5 c.c. amounts. Time must be allowed for the solution to reach 20° C. If the bath be large enough, little attention is needed to keep the temperature constant. The culture having been brought to 20° C., is then added in 0.1 c.c. amounts and the tubes shaken, an interval of thirty seconds allowed between each tube. Subinoculation of the first tube is then made after thirty seconds, which gives an interval of two and a half minutes after inoculation. The tubes are then subinoculated in order at thirty-second intervals, giving an interval for each of two and one-half minutes after inoculation, and starting at the first, gives an interval of five minutes, etc.

It is possible to use ten tubes, as each step can be done in less than fifteen seconds if properly arranged, allowing a much wider range for each test. It is not necessary to keep the cotton plugs in the tube during the operation nor to remove the tubes from the bath to obtain the loopful for inoculation. The loop is plunged to the bottom, care being taken not to touch the sides of the tubes, and care should also be taken that a loopful is carried away each time. The broth tubes are incubated for forty-eight hours and then examined for growth.

The following are given as two examples:

		Time of exposure:						
Sample.	Dilution.	2.5 min.	5 min.	7.5 min.	10 min.	12.5 min.	15 min.	Phenol coefficient.
Phenol . . .	1 to 90	+	−	−	−	−	−	100)550
	1 to 100	+	+	+	−	−	−	5.5
Disinfectant A .	1 to 450	+	+	−	−	−	−	
	1 to 550	+	+	+	−	−	−	
	1 to 600	+	+	+	+	−	−	
Phenol . . .	1 to 100	+	+	+	−	−	−	110)650
	1 to 110	+	+	+	+	+	−	5.191
Disinfectant A .	1 to 600	+	+	+	+	−	−	
	1 to 650	+	+	+	+	+	−	
	1 to 700	+	+	+	+	+	+	

These tables not only serve as an example, but also show that unless many repetitions of the tests are made and averaged, considerable variations in the results may be obtained. A report of 5.5 or 5.1 is equally accurate in the test here reported of the Rideal-Walker method, even with certain improvements added. With practice, and by selection of the dilutions to be employed, the operator evidently can regulate the time factor so that fairly uniform results are obtainable. On the other hand, it not infrequently happens that if more than one carbolic dilution is employed, more than one time period is open to comparison. For these reasons Anderson and McClintic have modified the test by setting two time limits two and one-half and fifteen minutes and taking the average. The following is an example:

		Time of exposure.						
Sample.	Dilution.	2.5 min.	5 min.	7.5 min.	10 min.	12.5 min.	15 min.	Phenol coefficient.
Phenol . . .	1 to 80	−	−	−	−	−	−	$\frac{375}{80}$ $\frac{650}{110}$
	1 to 90	+	−	−	−	−	−	
	1 to 100	+	+	+	−	−	−	
	1 to 110	+	+	+	+	+	−	
Disinfectant A .	1 to 350	−	−	−				
	1 to 375	−	−	−				$\frac{4.69 + 5.91}{2} = 5.30$
	1 to 400	+	−	−	−			
	1 to 425	+	+	−	−	−	−	
	1 to 450	+	+	−	−	−	−	
	1 to 500	+	+	−	−	−	−	
	1 to 550	+	+	+	−	−	−	
	1 to 600	+	+	+	+	−	−	
	1 to 650	+	+	+	+	+	−	
	1 to 700	+	+	+	+	+	+	
	1 to 750	+	+	+	+	+	+	

Disinfectants vary widely in their germicidal properties, depending on whether organic matter is present or not. As under practical conditions organic matter is usually present, it is of some importance to know how far organic matter decreases the efficiency.

For the purpose of obtaining comparable results, Anderson and McClintic have suggested the use of peptone 10 per cent. and gelatin 5 per cent. in distilled water. One part of the culture is mixed with 10 parts of the organic solution, 1.1 c.c. being then added to a series of dilution tubes containing 4 c.c. In determining the coefficient allowance must be made for the added amount of organic matter.

The modified methods of Anderson and McClintic[1] are called the "hygienic laboratory phenol coefficient," with or without organic matter. Any organic matter may be used in the test to approach the special conditions under which a disinfectant is to be used.

In comparing the value of disinfectants the cost as well as the coefficient must be considered. This is best stated in terms of the

[1] See Hygienic Laboratory Bulletin No. 82, for further details and apparatus for simplifying the steps of the test.

relative cost of 100 units of efficiency as compared with pure phenol = 100, thus:

$$\frac{\text{Cost of disinfectant per gallon}}{\text{Cost of phenol per gallon}} (= \text{Cost ratio}) \div \frac{\text{Coefficient of disinfectant}}{\text{Coefficient of phenol (1)}}.$$

(= the efficiency), × 100 = relative cost per 100 units.

Antiseptic Value.—With certain disinfectants there is sufficient of the disinfectant carried over by the loop to exert antiseptic action and growth does not occur. If this is not taken into consideration a disinfectant will be given an excessively high coefficient. No satisfactory method has been devised to avoid this difficulty. The inoculated broth tube may be shaken and a loop or more inoculated from it to second broth tube, in this way diluting the disinfectant still further.

Chick[1] has attempted to overcome the difficulty in the case of mercury-containing disinfectants by adding 0.2 c.c. of a saturated watery solution of hydrogen sulphide to each tube of broth.

Many substances which are strong disinfectants become altered under the conditions in which they are used, so that they lose a portion or all of their germicidal properties; thus, quicklime and milk of lime act by means of their alkali and are disinfecting agents only so long as sufficient calcium hydroxide is present. If this is changed by the carbon dioxide of the air into carbonate of lime it becomes harmless. Bichloride of mercury and many other chemicals, form compounds with many organic and inorganic substances, which, though still germicidal, are much less so than the original substances. Solutions of chlorine, peroxides, etc., when in contact with an excess of organic matter soon become inert because of the chemical compounds formed.

Thymol and eucalyptol have about one-fourth the strength of carbolic acid (Behring).

Oil of peppermint in 1 to 100 solution prevents the growth of bacteria.

Tables of Antiseptic Values.[2]

Alum	1 to 222	Mercuric chloride	1 to 14,300
Aluminum acetate	1 to 6000	Mercuric iodide	1 to 40.000
Ammonium chloride	1 to 9	Potassium bromide	1 to 10
Boric acid	1 to 143	Potassium iodide	1 to 10
Calcium chloride	1 to 25	Potassium permanganate	1 to 300
Calcium hypochlorite	1 to 1000	Pure formaldehyde	1 to 25,000
Carbolic acid	1 to 333	Quinine sulphate	1 to 800
Chloral hydrate	1 to 107	Silver nitrate	1 to 12,500
Cupric sulphate	1 to 2000	Sodium borate	1 to 14
Ferrous sulphate	1 to 200	Sodium chloride	1 to 6
Formaldehyde (40 per cent.)	1 to 10,000	Zinc chloride	1 to 500
Hydrogen peroxide	1 to 20,000	Zinc sulphate	1 to 20

[1] Journal of Hygiene, 1908, viii, 654.

[2] These figures are approximately correct, and represent the percentage of disinfection required to be added to a fluid containing considerable organic material, in order permanently to prevent any bacterial growth. Solutions of half the given strength will inhibit the growth of most bacteria and prevent the growth of many varieties.

AVERAGE ACTION OF REPRESENTATIVE DISINFECTANTS ON SOME OF THE MORE IMPORTANT PATHOGENIC BACTERIA.

Kind of bacteria.	Thermal death-point.			Kind of media.	Mercuric chloride, 1 to 1000.	Hydrogen peroxide, 1 to 200.	Carbolic acid, 1 to 100.	Formalin, 1 to 50.	Trichloride of of iodine, 1 to 750.	Copper sulphate, 1 to 200.	Tricresol, 1 to 200.	Chloramin, 1 to 10,000
	100°	80°	55° C.									
Typhoid bacilli	..	..	15[1]	Non-albuminous	1[1]	5	5	5	..	..	1	
				Albuminous[2]	5	20	15	15	..	..	5	5
B. coli	..	..	20	Non-albuminous	5	..	15					
				Albuminous	70	..	70	20				
Diphtheria bacillus	..	5	20	Non-albuminous	1	10	5	3	1	2	1	
				Albuminous	5	20	10	5	5	5	5	5
Staphylococcus	2	5	60	Non-albuminous	15	15	20	20				
				Albuminous	30	30	30	40				
Streptococcus	..	..	20	Non-albuminous	5	5	5	5	5	5	5	
				Albuminous	10	15	40	30	..	10	10	
Pneumococcus	..	..	20	Non-albuminous	5	5	5	5	5	5	5	
				Albuminous	..	..	10	10				
Meningococcus	..	..	25	Non-albuminous	1	3	1	1	..	..	1	
				Albuminous	5	15	5	5	..	..	5	5
B. anthracis spores	150	..	..	Non-albuminous	180 at 75° C.	..	150 at 75° C.					
				Albuminous								

[1] The time is given in minutes.

[2] The tests made with albuminous media were by Willa Noble in our Laboratory. The cultures were grown twenty-four hours at 37° C. in glucose ascitic broth, one-tenth of culture inoculated into 5 c.c. of disinfectant, temperature 20° C.

Practical Application of Disinfection.—It is best applied at the source of infection. The excretion of the patient, especially those from the mouth, nose and bowels, most frequently need disinfection. When proper measures have been taken at the bedside to prevent the spread of infection in a case of typhoid fever or diphtheria, subsequent disinfection of the sick room will not be necessary, but when there is any doubt of diffusion of the infection, then a general disinfection is advisable.

It is equally important to know *how* and *what* to disinfect as *when* and *where* to disinfect. No one should attempt to disinfect any given place unless he is familiar with the peculiarities of the particular infection with which he has to deal and has a thorough knowledge of the disinfecting agents employed. Personal attention to minute details is also necessary to secure success in disinfection. The materials, the strength of solutions, modes of application, effect of temperature, humidity, outside winds, porosity of walls, shape and size of enclosures, etc., must be thoroughly understood, in order to obtain the best results. As a guide and check to the thoroughness of the process, and the degree of penetration, every gas disinfection should be controlled. This may be done by saturating threads with an active culture of *Bacillus pyocyaneus*, which are enclosed in thin paper envelopes and exposed in various parts of the room to be disinfected. These threads, at the end of the operation, are dipped into Dunham's peptone solution, when, if the controls have survived, this is shown by the characteristic green coloration in the medium.

Terminal Disinfection.—This has largely been dispensed with. The reasons are, because it has little effect upon the control of the communicable diseases, and because the cost of such fumigation appears to be disproportionately large to the results obtained. It is much more important to destroy the infective discharges throughout the course of the disease than to trust to one final disinfection of the sick-room and its contents. Fomites are now known to play a comparatively minor role in the spread of infection. The principal objects that need disinfection are the discharges from the body: towels, beddings, handkerchiefs and clothing; food; tableware and other objects that have been used by the patient in eating and drinking; and finally the hands of the nurse, physicians and others who come in contact with the infection. Terminal disinfection, however, would still seem to be worth while, if it prevents the occurrence of only a small number of cases. Terminal *fumigation* for measles, scarlet fever and certain other short-lived viruses may not be necessary, but *disinfection* of objects likely to convey disease will always be required.

Penetration.—Most disinfectants have but little power of penetration. Substances in solution penetrate better than those in emulsion. Gaseous substances cannot be depended upon to penetrate beyond one or two thicknesses of cloth unless aided by heat, their action being only on the surface. The most difficult objects to penetrate, and at the same time the most important as usually containing virulent pathogenic microörganisms throughout their mass, are feces

and sputum. Such substances, therefore, must be thoroughly disintegrated and the disinfectant incorporated throughout the mass in order to permeate it in a reasonable time. In certain instances dependence should be placed only in steam, dry heat, or boiling, to effect necessary penetration. Upholstered furniture, mattresses, pillows, thick blankets and the like, cannot be penetrated by any of the ordinary chemical disinfectants. The bacteria that remain alive in them are probably safely held prisoners.

The *albuminous matter* in which bacteria are usually embedded naturally seriously interferes with the efficiency of all disinfectants. Chlorinated lime and permanganate of potassium actively attack albuminous matter and are thus soon reduced. Formaldehyde and carbolic acid show less reduction of power in the presence of albuminous matter than perhaps any other disinfectant.

Time is a very important element in disinfection. Even in moderately strong solutions and under favorable conditions, very few chemical disinfectants act instantly. It is not enough to simply dip the hands in and out of a bichloride solution, to rinse fabrics in carbolic acid solution, or to pour formalin over feces. It takes time to penetrate and then to destroy the life of the germs after the disinfectant comes in direct contact with it.

In applying any disinfecting agent enough of the substance must be used so that the proportion required shall be present throughout the whole mass in the right dilution This is particularly important in the disinfection of urine, feces, sputum and the like.

Choice of Disinfectants.—The choice of the chemical to be used depends somewhat on the nature of the substance to be disinfected, as well as upon the resistance of the bacteria or virus. For instance, ordinary germicidal solutions such as bichloride of mercury, 1 to 1000, or carbolic acid, 2½ per cent., cannot be trusted to kill tetanus spores; emulsions are not serviceable for the disinfection of feces; a weak chlorinated lime will disinfect water, but a strong solution is necessary to disinfect fabrics, but the strong solution bleaches and rots the fiber. Certain chemicals have a selective action and appear to be specific poisons for some organisms as, for example, copper sulphate for algæ. On the other hand, carbolic acid is ineffective against the virus of smallpox. The choice of the chemical, therefore, its strength, and time of application, the temperature of the solution, and its method of employment, are all problems which must be solved for each particular class of infection, and each particular group of substances.

PRACTICAL DISINFECTION AND STERILIZATION (HOUSE, PERSON, INSTRUMENTS, AND FOOD). STERILIZATION OF MILK FOR FEEDING INFANTS.

Disinfectants and Methods of Disinfection Employed in the House and Sickroom.—Disinfection and Disinfectants.—Sunlight, pure air, and cleanliness are always very important agents in maintaining

health and in protecting the body against many forms of disease. When, however, it becomes necessary to guard against such special dangers as infectious material from communicable diseases the additional protection of disinfection must be resorted to. Sunlight destroys only what it reaches and absolute removal of infectious material is difficult to attain and to be certain of. In order that disinfection shall afford complete protection it must be thorough; and an attempt at perfect cleanliness is better, even in the presence of contagious disease, than filth with incomplete disinfection.

As few articles as possible should be exposed to the germs causing the communicable disease, for they may become carriers of infection. It is important, therefore, when conditions allow it, that all articles not absolutely necessary for the care and comfort of the sick person, especially upholstered furniture, carpets and curtains, should be removed from the room before placing the patient in it.

Agents for Cleansing and Disinfection.—Too much emphasis cannot be placed upon the importance of cleanliness, both as to the person and the dwelling, in protecting the body from all kinds of infectious diseases. Sunlight and fresh air should be freely admitted, and personal cleanliness should be attained by frequently washing the hands and body, replacing fabrics infected by expectoration, bowel discharges, etc. By these means most of the bacteria are removed.

Cleanliness in dwellings, and in all places which men frequent, may ordinarily be maintained by the use of the two following solutions:

1. *Soapsuds Solution.*—For simple cleansing, or for cleansing after the methods of disinfection by chemicals to be described, one ounce of common soda should be added to twelve quarts of hot soapsuds (soft soap and water.)

2. *Strong Soda Solution.*—For a stronger and more effective cleansing solution, which is also a fairly efficient disinfectant, dissolve one-half pound of common soda in three gallons of hot water. The solution thus obtained should be applied by scrubbing with a hard brush.

When it becomes necessary to prevent the spread of communicable diseases by killing the living germs which cause them, more powerful agents must be employed than those required for simple cleanliness, namely, *disinfectants*. The following are some of the most reliable disinfectants:

1. *Heat.*—Complete destruction by fire is an absolutely sane method of disposing of infected articles of little value, but continued high temperatures not so high as to injure most materials will also destroy all life. Thus, boiling or steaming in closed vessels for ten minutes will destroy all disease germs except those containing the most resistant spores. Dry heat at 150° C. will destroy vegetative forms in a few minutes and spores in from one to two hours.

2. *Carbolic Acid Solution.*—Pure carbolic acid (phenol) crystallizes in long, colorless crystals, deliquesces in contact with air, and has a penetrating odor and burning taste. It is a corrosive poison. It dis-

solves in water with some difficulty and should be thoroughly mixed, therefore. It is not destructive to fabrics, colors, metals, or wood, and does not combine as actively with albuminous matters as bichloride of mercury. It is thus more suitable for the disinfection of feces. The cost of pure carbolic acid solutions is much greater than that of most of the other disinfecting solutions but except for disinfections of the skin, which in some persons it irritates, it is generally to be preferred by those not thoroughly familiar with disinfectants, as it does not deteriorate and is rather more uniform in its action than some of the other agents.

To prepare carbolic acid solution dissolve six ounces of carbolic acid in one gallon of hot water (200 grams in 4000 c.c.). This makes approximately a 5 per cent. solution, which, for most purposes, may be diluted with an equal quantity of water. The commercial "soluble crude carbolic acid," which is cheaper and twice as effective as the pure carbolic acid, can be used for privies and drains. It makes a white emulsion on account of its not entering readily into solution. Care must be taken that the pure acid does not come in contact with the skin.

3. *Bichloride Solution.*—Bichloride of mercury or corrosive sublimate is one of the most powerful germicides. This substance, which dissolves in 16 parts of cold water, when present in 1 part in 100,000 in nutrient gelatin or bouillon, inhibits the development of most bacteria. In water 1 part in 50,000 will kill many varieties in a few minutes, but in bouillon twenty-four hours may be needed. Many spores are killed in 1 to 500 watery solution within one hour. Corrosive sublimate is less effective as a germicide in alkaline fluids containing much albuminous substance than in watery solution; precipitates of mercury are found which are at first insoluble, so that a part of the mercury salts does not exert any action. For ordinary use, solutions of 1 to 500 and 1 to 2000 will suffice, when brought in contact with bacteria in that strength, to kill the vegetative forms within one to twenty minutes, the stronger solution to be used when much organic matter is present.

To prepare bichloride solution dissolve sixty grains of pulverized corrosive sublimate and two tablespoonfuls of common salt in one gallon of hot water. This solution, which is approximately 1 to 1000, must be kept in glass, earthen, or wooden vessels (not in metal receptacles). For safety it is well to color the solution.

Both the carbolic and bichloride solutions are very poisonous when taken by the mouth, but are harmless when used externally. The disadvantages of the bichloride solution are that it corrodes metals, irritates the skin in strong solution, and forms almost inert compounds with albuminous matter.

4. *Milk of Lime.*—Calcium hydroxide is a powerful disinfectant; the carbonate, on the other hand, is almost without effect. Milk of lime is made by adding one quart of dry, freshly slaked lime (calcium hydroxide) to four or five quarts of water. The lime is slaked by

pouring a small quantity of water on a lump of quicklime. The lime becomes hot, crumbles, and as the slaking is completed a white powder results. This powder is used to make milk of lime. Air-slaked lime (the carbonate) has no value as a disinfectant. A 1 per cent. solution of calcium hydroxide kills bacteria which are not in the spore form within a few hours. A 20 per cent. solution added to equal parts of feces or other filth and mixed thoroughly will completely sterilize them within two hours.

5. *Dry Chlorinated Lime or so-called "Chloride of Lime."*—It should not contain less than 10 per cent. of available chlorin, and can now be obtained containing 30 per cent. It should have a strong, pungent odor of chlorine. Its efficacy depends on the chlorine it contains in the form of hypochlorite of lime. A solution in water of 0.5 to 1 per cent. of chlorinated lime will kill most bacteria in one to five minutes, and 1 part in 100,000 will destroy typhoid bacilli in twenty-four hours. A 5 per cent. solution usually destroys spores within one hour. Chlorinated lime not only bleaches, but destroys fabrics. It must be fresh and kept in closed vessels or packages.

Labarraque's solution of the hypochlorites is practically the same as chlorinated lime and is much more expensive.

6. *Formalin.*—This is a watery solution containing 40 per cent. of formaldehyde. If 1 part of formalin is added to 10 parts of water, the resultant solution has the disinfecting value of the 5 per cent. carbolic acid solution.

7. *Creolin, Tricresol and Lysol.*—Cresol has about the same disinfecting value as pure carbolic acid; tricresol and lysol are about three times as powerful.

The proprietary disinfectants, which are so often widely advertised, and whose composition is kept secret, are relatively expensive and frequently unreliable or inefficient. Their value should be stated in comparison with carbolic acid, so that their strength may be known. It should be remembered that substances which destroy or disguise bad smells are not necessarily disinfectants, and that there are very few disinfectants that are not poisonous when taken internally.

The diseases to be commonly guarded against, outside of surgery, by disinfection are scarlet fever, measles, diphtheria, tuberculosis, smallpox, typhoid fever, bubonic plague, and cholera.

Disinfection of Hands and Person.—Dilute the 5 per cent. carbolic acid solution with an equal amount of water or use the 1 to 1000 bichloride solution without dilution. Hands soiled in caring for persons suffering from contagious diseases, or soiled portions of the patient's body, should be immediately and thoroughly soaked with one of these solutions and then washed with soap and water, and finally immersed again in the solutions. The nails should always be kept short and clean. Before eating, the hands should be first washed in one of the above solutions, and then thoroughly scrubbed with soap and water by means of a brush.

Soiled Clothing, Towels, Napkins, Bedding, etc., should, on removal, be immediately immersed in the 2.5 per cent. carbolic acid solution, in the sick room, and soaked for one or more hours. Articles such as beds, woolen clothing, etc., which cannot be washed, should be thoroughly exposed to formaldehyde gas. This is not necessary after measles.

3. **Food and Drink.**—Food thoroughly cooked and drinks that have been boiled are free from disease germs. Foods and drinks, after cooking or boiling, if not immediately used, should be placed when cool in clean dishes or vessels and covered. In the presence of an epidemic of cholera or typhoid fever, milk and water used for drinking, cooking, washing dishes, etc., should be boiled before using, and all persons should avoid eating uncooked food and fresh vegetables.

4. **Discharges of all Kinds from the Mouth, Nose, Bladder, and Bowels** of patients suffering from contagious diseases should be received into glass, metal or earthen vessels containing the carbolic acid solution, or milk of lime, or they should be removed on pieces of cloth, which are immediately immersed in one of these solutions or boiled or destroyed by fire. Special care should be observed to disinfect at once the vomited matter and the intestinal discharges from cholera patients. In typhoid fever the urine and the intestinal discharges, and in diphtheria, measles, and scarlet fever the discharges from the throat and nose all carry infection and should be treated in the same manner. The volume of the solution used to disinfect discharges should be at least twice as great as that of the discharge, and should completely mix with it and cover it. The strength of the disinfectant solution is reduced according to its dilution in the final mixture. After standing for an hour or more the discharges, with the exception of the feces, may be thrown into the water-closet.

Masses of feces are extremely difficult to disinfect except on the surface, for it takes disinfectants such as the carbolic acid solution some twelve hours to penetrate to their interior. If fecal masses are to be thrown into places where the disinfectant solution covering them will be washed off, it will be necessary to be certain that the disinfectant has previously penetrated to all portions and destroyed the disease germs. This can be brought about by stirring them with the disinfectant and allowing the mixture to stand for one hour, or by washing them into a pot holding soda solution which is already at the boiling temperature, or later will be brought to boiling.

5. **Sputum from Consumptives.**—The importance of the proper disinfection of the sputum is still underestimated. Consumption is an infectious disease, and is always the result of transmission from the sick to the healthy or from animals to man. The sputum contains the germs which cause the disease, and in a large proportion of cases is the source of infection which is especially dangerous in early childhood. In all cases, therefore, the sputum should be disinfected when discharged. It should be received in covered cups containing the carbolic acid or milk of lime solution. Handkerchiefs soiled by sputum should be soaked in the carbolic acid solution and then boiled. Dust

from the walls, mouldings, pictures, etc., in rooms that have been occupied by consumptive patients, where the rules of cleanliness have not been carried out, contain the germs and will produce tuberculosis in animals when used for their inoculation; therefore, rooms should be thoroughly renovated or disinfected before they are occupied by others.

6. **Closets, Kitchen and Hallway Sinks, etc.**—The closet should never be used for disinfected discharges until they have been thoroughly disinfected; when done as an additional safeguard, one quart of carbolic acid solution or 5 per cent. solution of formalin should be poured into the pan (after it is emptied) and allowed to remain there. Sinks should be flushed at least once daily.

7. **Dishes, Knives, Forks, Spoons,** etc., used by a patient should, as a rule, be kept for his exclusive use and not removed from the room. This will prevent accidents. They should be washed first in the carbolic acid solution, then in boiling hot soapsuds, and finally rinsed in hot water. The remains of the patient's meals may be burned or thrown into a vessel containing the carbolic acid solution of milk of lime, and allowed to stand for one hour before being thrown away.

8. **Rooms and Their Contents.**—Rooms which have been occupied by persons suffering from contagious disease should not be again occupied until they have been thoroughly cleaned. If this is done thoroughly disinfection is not necessary, since it is true that when the patient is freed from isolation probably the great majority of disease germs have already died. If any remain in places where they might cause infection they will almost certainly be removed while the rooms are being cleaned. It may be advisable to do it, however, so as to give a feeling of security to those who are to occupy the rooms. The danger from infection is much greater when cases are removed during the acute illness. For disinfecting rooms careful fumigation with formaldehyde gas should be employed unless vermin are to be killed, when sulphur fumes should be substituted. Carpets, curtains and upholstered furniture which have been soiled by discharges, or which have been exposed to infection in the room during the illness, may be removed for disinfection to chambers where they can be exposed to formaldehyde gas and moderate warmth for twelve to twenty-four hours, or to steam. Some carpets, such as many Wiltons, are discolored by moist steam, while formaldehyde fumigation gives only surface disinfection it is sufficiently effective, since any germs which penetrated the carpets or furniture so deeply as to be unaffected are so held as to be harmless. Wood-work, floors and plain furniture must be thoroughly washed with the soapsuds and bichloride solution. After the disinfection is finished it is well to remove the dried bichloride of mercury from the walls and wood-work.

9. **Rags and Other Articles of Little Value,** which have been soiled by discharges or infected in other ways, should be boiled or burned.

10. **In case of death** the body should be completely wrapped in several thicknesses of cloth wrung out of the carbolic or bichloride solution, and when possible placed in a hermetically sealed coffin.

Methods of Cleanliness and Disinfection to be Used in Homes and Public Places.—1. **Water-closet Bowls and all Receptacles for Human Excrement** should be kept perfectly clean by frequent flushing with a large quantity of water, and as often as necessary disinfected with crude carbolic acid or other efficient solution. The wood-work around and beneath them should be frequently scrubbed with the hot soapsuds solution.

2. **Cesspool and Privy Vaults.**—An abundance of milk of lime or chlorinated lime should be thrown into these daily, and their contents should be frequently removed.

3. **The Woodwork in School Houses.**—Floors, door-handles and all woodwork touched by the scholars' hands should be scrubbed daily with hot soapsuds.

4. **Spittoons in all Public Places** should be emptied daily and washed with the hot soapsuds solution, after which a small quantity of the carbolic acid solution or milk of lime should be put in the vessel to receive the expectoration.

5. **Cars, Ferry-boats and Public Conveyances.**—The floors, door-handles, railings, and all parts touched by the hands of passengers should be washed frequently with the hot soapsuds solution. Slat-mats from cars, etc., should be cleaned by scrubbing with a stiff brush in the hot soapsuds solution.

The Practical Employment of Formaldehyde Gas in the Surface Disinfection of Rooms and the Disinfection of Goods which would be Injured by Heat.—Formaldehyde gas has come into such general use and is for many purposes so valuable, that a somewhat detailed description may be given of the methods employed to generate and use it.

The destructive action of formaldehyde gas in microörganisms depends upon a number of factors, in its practical application for purposes of disinfection. The chief of these are its concentration in the surrounding atmosphere, the length of the contact, the existing temperature, the accompanying moisture, and the nature of the organism. It is not an efficient insecticide as sulphur dioxide is, but has the great advantage of not injuring the materials to be disinfected.

Concentration.—The necessary concentration of gas in the surrounding atmosphere varies with each species of microörganisms which are to be killed, as some of these resist chemical agents much more than others, and also with the freedom of access of the gas to the bacteria, for if they are under cover or within fabrics a greater amount of gas must be generated than if they are freely exposed.

For purely surface disinfection, when the common pathogenic bacteria are to be destroyed, there will be required, according to the method used, ten to twelve ounces of formalin of full strength, or its equivalent to 1000 cubic feet of air space.

If the gas is to pass through heavy goods the concentration must be doubled and moderate heat added (45° C. or above), as the gas penetrates through fabrics with difficulty.

Although formaldehyde gas does destroy bacteria with the amount of moisture usually present in the air, it acts much more powerfully and certainly when additional moisture is present, and best when it is present up to the point of saturation.

Temperature.—Every additional degree of temperature increases not only the activity of formaldehyde gas, but also its penetrating power. For heavy goods it is essential to have a moderately high heat, but one still below that which would injure fabrics. The production of a partial vacuum in the chambers before the introduction of the gas still further assists its penetration.

Length of Exposure.—This depends upon the nature of the disease for which the disinfection is carried out, also upon the penetration required, the concentration of the gas used, the amount of moisture in in the air, temperature of the air, and the size and shape of the room. For surface disinfection in rooms, when as much as twelve ounces of formalin are used for each 1000 cubic feet, five hours' exposure is amply sufficient, most bacteria being killed within the first thirty minutes. For the destruction of microörganisms protected by even a layer of thin covering, double the amount of formalin and double the time of exposure should be allowed, and even then the destruction of many species of non-sporebearing bacteria, in ordinary rooms, cannot be depended upon. When complete disinfection is demanded, and deep penetration of gas is required, the goods must be placed in chambers where moderate heat can be added and all leakage of gas prevented.

In order to insure complete sterilization of the articles they should be so placed as to allow of a free circulation of the gas around them—that is, in the case of bedding, clothing, etc., these should either be spread out on perforated wire shelves or loosely suspended in the chamber. The aid of a partial vacuum facilitates the operation. Upholstered furniture and articles requiring much space should be placed in a large chamber, or, better, in a room which can be heated to the required temperature.

The most delicate fabrics, furs, leather, and other articles, which are injured by steam, hot air at 230° F., or other disinfectants, are unaffected by formaldehyde in either texture or color.

The vapors of formaldehyde are extremely irritating to the mucous membrane of the eyes, nose and mouth, causing profuse lacrimation, coryza, and flow of saliva; but so far as known formaldehyde gas is comparatively non-toxic to the higher forms of animal life. Nevertheless, a certain degree of caution should be observed in the use of this agent. It is practically inert as an insecticide except in extremely great concentrations; such insects as roaches, flies, and bedbugs, are not, as a rule, affected.

Disinfection of Books.—Books may be satisfactorily disinfected by means of formaldehyde gas in a special room, or in the ordinary steam chambers, as above described, and under the same conditions of volume of gas, temperature and time of exposure. The books should

be arranged to stand as widely open as possible upon perforated wire shelves, set about one or one and a half feet apart in the chamber. A chamber having a capacity of 200 to 250 cubic feet would thus afford accommodation for about one hundred books at a time.

Books, with the exception of their surfaces, cannot be satisfactorily disinfected by formaldehyde gas in the book cases of houses or libraries, or anywhere except in special chambers constructed for the purpose, because the conditions required for their thorough disinfection cannot otherwise be complied with. It is hardly conceivable that such books could have been infected.

The bindings, illustrations, and print of books are in no way affected by the action of formaldehyde gas.

Disinfection of Carriages, etc.—Carriages, ambulances, cars, etc., can easily be disinfected by having built a small, tight building in which they can be enclosed and surrounded with formaldehyde gas. Such a building is used for disinfecting ambulances in New York City. With the apparatus thus employed a large amount of formalin is rapidly vaporized and superficial disinfection is completed in sixty minutes.

Methods of Providing Formaldehyde Gas.—Formaldehyde, or formic aldehyde, was originally obtained by von Hoffmann (1867) by passing the vapor of methyl alcohol (wood alcohol) mixed with air over finely divided platinum heated to redness. Formaldehyde is a gaseous compound with an extremely irritating odor. At a temperature of 68° F. the gas is polymerized—that is to say, a second body is formed, composed of a union of two molecules of formaldehyde. This is known as "paraformaldehyde," and is a white soapy body, soluble in boiling water and in alcohol. Formaldehyde is sold in commerce as a clear, watery liquid containg from 33 to 40 per cent. of the gas and 10 to 20 per cent. of methyl-alcohol, its chief impurity. This solution is known as "formalin." If formalin is evaporated or concentrated above 40 per cent., paraformaldehyde results; and when this is dried *in vacuo* over sulphuric acid a third body, "trioxymethylene," is produced, consisting of three molecules of formaldehyde. This is a white powder. The solid polymers of formaldehyde, when heated, are again reduced to the gaseous condition; ignited, they finally take fire and burn with a blue flame. When burned they have no germicidal properties.

Various forms of apparatus can be properly employed to liberate formaldehyde gas for purposes of disinfection. There are two essentials to any good method, namely, that the formaldehyde gas is given off quickly, and that there is no great loss by deterioration of the formalin.

Wood Alcohol.—A number of lamps have been devised, all very much on the principle originally proposed, which bring about the incomplete oxidation of methyl alcohol by passing the vapors mixed with air over incandescent metal. Although disinfection can be carried out by the best of these lamps, none of them up to the present time have proved to be satisfactory.

Trioxymethylene or Paraform.—This system consists in heating the solid polymer of formaldehyde, of which there are several methods. They are somewhat expensive but efficient and are very generally used. The formaldehyde must be protected from burning to retain its germicidal properties. A number of outfits are made which consist of a receptacle holding the paraform and another for producing the heat. It is well to use about twice the amount advised by the manufacturer in order to be certain of the result.

Formalin.—The commercial solution known as formalin, containing about 40 per cent. of formaldehyde gas, is also commonly employed in the various methods of generating the gas for disinfecting purposes. It is not always up to standard, and, being volatile, there is a certain loss if not well kept. In winter there is a decided deterioration, owing to the polymerization of trioxymethylene. For these reasons it is well to use an excess of the liquid in practical work if the exact strength of the formalin has not recently been determined. There are several methods in common use for liberating formaldehyde gas from formalin, a few of which may be mentioned.

1. *Formalin by Boiling and Passing the Vapor through a Superheated Coil or Chamber.*—This system consists in heating the ordinary formalin to a high temperature in an incandescent copper coil or chamber, and allowing the vapors to pass off freely. It is claimed for this method that the degree of heat necessary to break up the polymerized products formed is supplied, and then a loss of formaldehyde is prevented. A further action of the intense heat in the copper tube on the solution is partially to convert the methyl alcohol contained in commercial formalin into formaldehyde gas by oxidation, thereby utilizing a part of the methyl alcohol and increasing the amount of formaldehyde.

2 *Formalin on Sheets.*—A very simple method is to pour on folded sheets 16 ounces of formalin per 1000 cubic feet and then stretch them out over lines in a room and leave for ten hours. If the room is tightly sealed very fair surface disinfection will take place.

3. *Lime and Permanganate of Potash with Formalin.*—Satisfactory results in disinfection have been obtained from the following combination of chemicals: 2 ounces of a quick-slaking, coarsely granular lime (calcium oxide); 5 ounces of permanganate of potash; ½ gram oxalic acid; 5 ounces formalin (40 per cent. strength); 2½ ounces of water. This is sufficient in quantity to disinfect 1000 cubic feet of space in five hours. It is used as follows: The lime and permanganate of potash are mixed together in a pan at least 10½ inches in diameter and 3½ to 4 inches in depth Over this is poured the freshly prepared mixture of formalin, oxalic acid and water A rapid evolution of gas takes place.

Another combination is: lime, 2.7 ounces; potassium permanganate 5.5 ounces; formalin, 7.4 ounces; water, 2.7 ounces. The technic is as follows: The lime and permanganate are mixed in a wide, deep pan as above, and the freshly prepared formalin and water mixture is poured over it.

4. *Lime and Formalin Method.*—To 10 ounces of 40 per cent. formalin slowly add 1 ounce of concentrated sulphuric acid; pour this solution on to 2 pounds of quicklime that has previously been broken into small lumps and placed in a dairy pan not less than 12 inches in diameter. The liberation of a large amount of gas in a short time more than compensates for the loss by polymerization, and disinfection is effected by a quick union of the gas and the microörganisms to be destroyed. Saturated solution of aluminum sulphate may be used instead of concentrated sulphuric acid.

Wilson's Formaldehyde Generator for Large Chambers.—This generator is made of ordinary iron steam pipe and can be manufactured in any pipe-cutting establishment in a few hours. It consists of an outer steam jacket of 6-inch pipe, 2 feet long, and capped at both ends. Through the upper cap there is a 4-inch opening, with a thread, through which projects an inner chamber for formalin. This chamber consists of a 4-inch pipe, 22 inches long, capped at the upper end and welded or capped at the lower end. The upper end of this pipe is so threaded as to permit of its being screwed through the cap of the outer or steam jacket before that cap is screwed on. The cap of the formalin chamber is fitted on the same thread that passes through the cap of the steam jacket. The intake for steam is near the top of the steam jacket, through a $\frac{1}{2}$-inch pipe, and the steam is controlled by a globe valve. The outlet for steam or drip is through a $\frac{1}{2}$-inch pipe from the bottom cap of the chamber and is controlled by a globe valve. The intake for formalin is through the upper cap of the formalin chamber by means of a $\frac{1}{2}$-inch pipe controlled by a globe valve. The outlet for formalin is a $\frac{1}{2}$-inch pipe through the upper cap of the formalin chamber.

Controls must be made to test the efficiency of room disinfection by any of the methods above described if it is necessary to know that all disease germs have been killed.

Sulphur Dioxide in House Disinfection.—Sulphur dioxide gas has been extensively used for the disinfection of hospitals, ships, houses, clothing, etc. This gas is a much more active germicide in a moist than in a dry condition—due, no doubt, to the formation of the more powerful disinfecting agent, sulphurous acid (H_2SO_3). In a pure state anhydrous sulphur dioxide (SO_2) does not destroy spores, and is not certain to destroy bacteria in the vegetative form. As the result of a large number of experiments with SO_2, however, as a disinfectant it has been determined that an exposure for eight hours to an atmosphere containing at least 4 volumes per cent. of this gas *in the presence of the moisture* usually present in the air will destroy most, if not all, of non-sporebearing pathogenic bacteria.

Four pounds of sulphur should be burned for every 1000 cubic feet; this will give an excess of gas. The sulphur should be broken into small pieces and put into a pan sufficiently large not to allow the melted sulphur to overflow. This pan is placed in a much larger pan holding a little water. The cracks of the room should be carefully

pasted up and the door, after closing, also sealed. Upon the broken sulphur is poured 3 to 4 ounces of alcohol and the whole lighted by a match. The alcohol is not only for the purpose of aiding the sulphur to ignite, but also to add moisture to the air. An exposure of eight to twelve hours should be given.

Sulphur fumigation carried out as above indicated is not as efficient as formaldehyde fumigation, but suffice for surface disinfection for diphtheria and the exanthemata.

Advantages of Formaldehyde Gas over Sulphur Dioxide for Disinfection of Dwellings.—Formaldehyde gas is superior to sulphur dioxide as a disinfectant for dwellings: (1) Because it is more efficient in its action; (2) because it is less injurious in its effects in household goods; (3) because when necessary it can be easily supplied from a generator placed outside of the room and watched by an attendant, thus avoiding, in some cases, danger of fire.

PUBLIC STEAM DISINFECTING CHAMBERS.

These are used much less than formerly. There are now few, if any, cities in which carpets, bedding and other materials are removed from rooms for disinfection after being occupied by persons suffering from contagious diseases.

These chambers should be of sufficient size to receive all necessary goods, and may be either cylindrical or rectangular in shape, and are provided with steam-tight doors opening at either end, so that the goods put in at one door may be removed at the other. When large the doors are handled by convenient cranes and drawn tight by drop-forged steel eye bolts swinging in and out of slots in the door frames. The chambers should be able to withstand a steam pressure of at least one-half an atmosphere, and should be constructed with an inside jacket, either in the form of an inner and outer shell or of a coil of pipes. This jacket is filled with steam during the entire operation, and is so used as to bring the goods in the disinfecting chamber up to the neighborhood of 220° F., before allowing the steam to pass in. This heats the goods, so that the steam does not condense in coming in contact with them. It is an advantage to displace the air in the chamber before throwing in the steam, as hot air has far less germicidal value than steam at the same temperature. To do this, a vacuum pump is attached to the piping, whereby a vacuum of fifteen inches can be obtained in the chamber. The steam should be thrown into the chamber in large amount, both above and below the goods, and the excess should escape through an opening in the bottom of the chamber, so as more readily to carry off with it any air still remaining. The live steam in the chamber should be under a pressure of two or three pounds so as to increase its action.

To disinfect the goods, place them in the chamber, close tight the doors, and turn the steam into the jacket. After about ten minutes, when the goods have become heated, a vacuum of 10 to 15 inches is

produced, and then the live steam is thrown in for twenty minutes. The steam is now turned off, a vacuum is again formed, and the chamber again superheated. The goods are now thoroughly disinfected and dry. In order to test the thoroughness of any disinfection, or any new chamber maximum, thermometers are placed, some free in the chamber and others surrounded by the heaviest goods. It will be found that, even under a pressure of three pounds, live steam will require ten minutes to penetrate heavy goods.

In the practical application of steam for disinfecting purposes it must be remembered that while moist steam under pressure is more effective than streaming steam, it is scarcely necessary to give it the preference, in view of the fact that most known pathogenic bacteria produce no spores and the spores of the few that so develop them are quickly destroyed by the temperature of boiling water, and also that "superheated" steam is less effective than moist steam. When confined steam in pipes is "superheated" after its generation, it has about the same germicidal power as hot, dry air at the same temperature.

Disinfection of Hands, Instruments, Ligatures and Dressings for Operations.—Instruments.—All instruments, except knives, after having been thoroughly cleansed, are boiled for three minutes in a 1 per cent. solution of washing soda. Knives, after having been thoroughly cleansed, are washed in alcohol or other non-corroding disinfectant and wiped with sterile gauze and then put into boiling soda solution for one minute. This will not injure their edges to any great extent.

Gauze.—Gauze is sterilized by moist heat in an Arnold steam sterilizer for one hour or in an autoclave for thirty minutes. It is placed in a perforated cylinder or wrapped in clean towels before being put in the sterilizer, and only opened at the operation.

Ligatures.—Catgut.—Boil for one hour in alcohol under pressure at about 97° C. It is often put in sealed glass tubes, which are boiled under pressure. These remain sterile indefinitely. The alcohol does not injure the catgut. If desired, the catgut can be washed in ether and then soaked a short time in bichloride before heating in alcohol. Silver wire, silk, silkworm gut, rubber tubing, and catheters are boiled the same as the instruments. Ligatures already sterilized in their containers are now supplied by dealers.

Hand Brushes.—These should be boiled in soda solution for ten minutes.

The Skin of Patients.—It is impossible to sterilize the deeper portions of the skin, but sufficient surface bacteria can be removed to render infection rare. The skin is washed thoroughly with warm green soap solution, then with alcohol, and finally with 1 to 1000 bichloride. A compress wet with a 25 per cent. solution of green soap may be placed on, covered with rubber tissue, and left for three to twelve hours, and after its removal the skin is washed with ether, alcohol, and bichloride solution, and then covered with a gauze compress previously moistened with 1 to 1000 bichloride of mercury solution. At the operation the skin is again scrubbed with green soap solution followed by

ether, alcohol, and then with the bichloride of mercury solution. In some places the bichloride compress is replaced one hour before the operation by a pad wet in 10 per cent. solution of formalin.

The Hands.—In one method the hands are washed in hot soap and water for five minutes, using the nail brush. They are then soaked in 85 per cent. alcohol for one minute and scrubbed with a sterile brush. They are finally soaked in a 1 to 1000 bichloride of mercury solution for two minutes. The alcohol and bichloride are sometimes combined and used together. Another method is as follows: Skin of operator is scrubbed for five minutes with green soap and brush, then washed in chlorinated lime and carbonate of soda in proportions to make good lather; washed off in sterile water, and then scrubbed with brush in warm bichloride of mercury solution 1 to 1000. Owing to the risk of leaving untouched bacteria under the nails and in cracks of the skin, sterilized rubber or cotton gloves are now being generally used in operations.

Mucous Membranes.—Here absolute sterilization cannot be achieved without serious injury to the tissues. The usual method is to use some cleansing solution with moderate germicidal properties so as to remove as many bacteria as possible and limit the activities for a time of those remaining, while the resistance of the tissues is left unimpaired. The following examples give some of the methods employed. The mucous membranes of the mouth and throat are cleansed by a solution consisting of equal parts of peroxide of hydrogen and lime water. In the nostrils it is better to employ the milder solutions, such as diluted Dobell's or listerine. These are also used in the mouth instead of the peroxide. The vagina is swabbed out thoroughly with sterile warm soaps and water, and then irrigated with a 2 per cent. carbolic acid or 1 to 1000 bichloride of mercury solution.

Wounds.—It is impossible to disinfect quickly the surfaces of infected wounds without doing injury to the tissues involved.

Various solutions such as neutral hypochlorite solutions advised by Dakin gradually clear a wound of infection.

Hypodermic and Other Syringes.—These when not boiled are sterilized by drawing up into them boiling water a number of times and then finally a 5 per cent. solution of carbolic acid, this to be washed out by boiling water after three minutes. If cold water is used the carbolic acid solution should remain in the barrel of the syringe for ten minutes. Great care should be taken to wash out all possible organic matter before using the carbolic acid or boiling to sterilize. Syringes made entirely of glass or of glass and asbestos can be boiled in soda solution.

THE STERILIZATION OR PASTEURIZATION OF MILK IN THE HOME.

Milk is best sterilized by heat, for nearly all chemicals, such as boric acid, salicylic acid, and formalin, are not only slightly deleterious

themselves but also make the milk less digestible, and therefore less fit for food. Formalin is the least objectionable of the three. Milk may be sterilized at a high or low temperature—that is, at the boiling temperature, or at a lower degree of heat obtained by modifying the steaming process. Milk heated as high a temperature as 100° C., is not altogether desirable for prolonged use for infants, as the high temperature causes certain changes in the milk which make it less suitable as food for them.

Complete sterilization destroys all the germs in milk, and so, if no new ones gain entrance, prevents permanently fermentative changes. This requires boiling for fifteen to forty-five minutes or two or three consecutive days, according to the presence or absence of certain spores.

Pasteurization.—The changes due to boiling are almost altogether avoided if a temperature below 70° C. is used. It is recommended, therefore, that the lowest temperature be used for partial sterilization which will keep the milk wholesome for twenty-four hours in the warmest weather and kill the tubercle, typhoid, and other non-spore-bearing bacilli. Raising the milk to a temperature of 60° C. for twenty minutes, 65° C. for fifteen, 70° C. for five, 75° C. for two, or 80° C. for one minute will accomplish this. Exposure for even one minute at 70° C. destroys 98 per cent. of the bacteria which are not in the spore form. Fully 99 per cent. of tubercle bacilli are destroyed. One of the many forms of apparatus for pasteurizing milk is the following:

(*a*) A tin pail or pot, about 10 inches deep by 9 inches in diameter, provided with the ordinary tin cover which has been perforated with eight holes each an inch in diameter.

(*b*) A wire basket, with eight nursing bottles (as usually sold).

(*c*) Rubber corks for bottles and a bristle brush for cleaning them.

Directions (Koplik).—Place the milk, pure or diluted (as the physician may direct) in the nursing bottles and put the latter in the wire basket. Pour only sufficient milk for one nursing in each bottle. Do not cover the bottles at first.

Having previously poured about two inches of water in the tin pail or pot and brought it to the boiling-point, lower the basket of nursing bottles slowly into the pail. Do not allow the bottles to touch the water or they will crack. Put on the perforated cover and let the steaming continue for ten minutes; then remove the cover and firmly cork each bottle. After replacing the cover, allow the steaming to continue for fifteen minutes. The steam must be allowed to escape freely or the temperature will rise too high.

The process is now complete. Place the basket of bottles in a cool, dark place or in an ice-chest. The bottles must not be opened until just before the milk is to be used, and then it may be warmed by plunging the bottle in warm water. If properly prepared the milk will taste but little like boiled milk.

The temperature attained under the conditions stated will not exceed in extreme cases 87° C. (188° C.).

In another admirable method (Freeman) a pail is filled to a certain mark with water, and then placed on the stove until the water boils. It is then removed, and immediately a milk-holder, consisting of a series of zinc cylinders, is lowered with its milk bottles partially full of milk. The cover is again applied. The heat of the outside water raises the temperature of the milk in ten minutes to about 65° C. (150° F.), and holds it nearly at that point for some time. After twenty minutes the milk-holder is removed, placed in cold water and quickly cooled. The milk is kept in the ice-chest until used. When milk is pasteurized in large quantities it should always be done by the "holding process" as the so-called "flask" pasteurization is unreliable. Milk should be pasteurized when it is as fresh as possible, and only sufficient milk for twenty-four hours should be pasteurized at one time. If after nursing the infant leaves some milk in the bottle, this should be thrown away.

Care of the Bottles.—After nursing, the bottles should be filled with a strong solution of washing soda, allowed to stand twenty-four hours, and then carefully cleaned with a bottle brush. The rubber corks and nipples after using should be boiled in strong soda solution for fifteen minutes and then rinsed and dried.

After milk has been heated it should, of course, never be put into unsterilized bottles, as this will partially defeat the object of heating.

CHAPTER V.

EPIDEMIOLOGY.

By GEORGE A. SOPER, Ph.D.

What is Epidemiology?—Epidemiology is the scientific study of infections. Infections are the links which connect one case of disease with another.

In its narrowest application epidemiology deals simply with the statistical aspects of epidemics. In its broadest sense it includes whatever conditions and things cause one case of disease to lead to another. In the sense in which it is used here, epidemiology means the study of infections from the analytical and practical standpoints with the object of determining the essential facts about their causation and showing how they may be controlled. This body of knowledge does not lie clearly within the province of any other branch or department of learning.

Epidemiology is a branch of applied science in that it makes use of the facts and principles of other sciences for the accomplishment of its ends. Like other departments of applied science, its scope is not confined to any particular type, kind or class of objects, reactions or functions but it appropriates to its use such results as it needs from whatever sources may be available. This free appropriation, together with a keen estimation of the data and a particularly rigid application of the inductive process of reasoning, are distinguishing marks of epidemiological work.

Epidemiology differs from hygiene in that the one is confined to the investigation of disease transmission while the other concerns itself with procedures which promote, or tend to promote, health: health being regarded not merely as the absence of disease but as a positive and variable condition of the body and mind. It differs from what has come to be known as the "public health" in that the latter concerns itself essentially with broad, administrative functions. Epidemiology may be contrasted with sanitary science which seeks to promote health through the observance of correct principles relating to the environment. Epidemiology possesses a more restricted field than hygiene or public health or sanitary science; it serves partly as a basis for all of these.

The object of epidemiology is to explain why diseases spread, what courses the infections follow, how they can be checked and to what extent they are likely to continue under given conditions. To design the minutæ of procedures for the prevention of disease is not the sole concern of epidemiology. To collect, test, evaluate, classify, assimilate and establish facts and principles from a mass of data is essentially

its business. Its highest duty is to establish the laws by which disease can be controlled.

What an Epidemiologist Should Know.—The epidemiologist should have a thorough grounding in science. It is desirable, but not necessary, that he should have a medical education. If he has not a medical degree few doctors will believe it possible that he can know anything about disease. He will consequently find that his best efforts are often undervalued, discredited and rendered futile. The epidemiologist should be a specialist and have had a definite course of instruction, and much field experience in the line of his specialty. With the bearing of the following sciences upon the subject of his work he should be sufficiently familiar to enable him to make practical use of the resources which they open to him: Pathology, bacteriology, parisitology, entomology and zoölogy, sociology, meteorology, medical history, hygiene, logic and graphics.

He should know the principal diagnostic factors of disease, not necessarily with the thoroughness of an expert diagnostician, but certainly with sufficiently clear perception to enable him to form a shrewd and independent judgment upon obscure cases in their various stages of development. With respect to the infectious diseases, he should know their periods of infectivity, their periods of incubation, the percentage of attacks to be expected from a given number exposed, the means of transmission, the means of prevention and the means of suppression.

He should know how to collect and tabulate data and how to analyze it. In the interpretations he should be keen to detect similarities and differences. He should know how to draw inferences and deductions and, where warranted, conclusions. He should be familiar with the ways of correlating data; he should know the theory of probabilities; how to make and use diagrams and curves both for analytical and illustrative purposes. Such things as spot maps and other record systems should be among his most familiar resources.

Methods and Resources.—Since epidemiology seeks to explain the occurrence of transmissible diseases it often becomes necessary, in order that those explanations may be correct, to test the validity of the data which are used and sometimes even to establish them.

In some respects the tracing of infection is like the tracing of crime, for although the one is purposely hidden while the other is not, the misconception with which the popular mind regards disease generally cause the facts to be lost in a tangle of conflicting evidence. The epidemiologist must learn the uncertain value of human testimony and be able to penetrate the disguise with which Nature consciously or unconsciously seeks to hide the truth. Always he must make notes —make notes. The value of his work will often depend entirely upon his industry in this direction.

Nowhere is it more necessary to be able to sift the essential from the non-essential, to follow the scent of investigation unerringly through a labyrinth of detail, to know how to confine the reasoning

to what is justified by the data, to know when a proposition is proved and not proved, to preserve a sense of proportion, of perspective.

Of the various kinds of data employed in epidemiological investigations, statistics of disease are among the most definite, informing and useful. They are seldom, however, as definite and accurate as they are supposed to be. The underlying diagnoses are often mistaken, the reports incomplete. Yet, in spite of this, vital statistics have been called the barometer of public health. Their value depends upon their use. To the epidemiologist statistics are the records not merely of facts, but of consequences and causes And it is with the conditions and causes which have led to diseases, and which may result from them, that his mind properly works.

The statistics and other data with which the epidemiologist deals are sometimes collected by others, sometimes by himself. If by others, they come to his desk in the form of reports, of prepared tabulations, of books of reference. Registrars, health officers, physicians, inspectors, bacteriologists, bureaus, boards, commissions may supply the facts. Seldom will the epidemiologist have the advantage of well-trained assistants unless he produces them himself. He must know how to school such help as he can get and how to make use of such abilities as are available.

In some cases the epidemiologist must take the field. He must visit hospitals, morgues, laboratories, public institutions, public works, dairies, ships, villages, camps. He must interview the sick, rich and poor, and learn to talk and to act with tact in such ways as will extract the needed data from all of them.

The epidemiologist's own conception of disease and its cause must throughout be kept clear and scientific. Whereas he should look upon disease as a reaction which varies within limits with different individuals, and with different circumstances, the microbic and other causes are specific. The causes may not all be known, but it is the business of the epidemiologist to be familiar with such as are established and to try to advance this knowledge as far as possible.

Common Objects and Higher Purposes.—Bearing in mind that an essential function of epidemiology is to investigate the hidden causes of disease, we may proceed to consider briefly the ways in which this knowledge may be turned to practical account.

The commonest end to be attained is the stopping of epidemics. Supposing scarlet fever, for example, has broken out in a school, it becomes necessary to determine how it originated, by what means it is being spread and hence in what manner it can be controlled. To make the necessary investigations and to propose the remedy is properly the work of an epidemiologist.

Again, typhoid fever continues to be prevalent in a city after large sums of money have been spent to improve the water supply and other sanitary works. To discover the cause of this unexpected condition of affairs requires an investigation which nobody so well as a trained epidemiologist can make.

Suppose vessels from alleged plague ports are arriving at a well-ordered city which has an efficient health department and in which the quarantine service is fully alive to its duties. Should the vessel be forbidden to discharge her cargo and take on a fresh one for her return voyage? If so, what precautions should be taken to insure safety? These questions may well be put up to an epidemiologist.

An unrecognized disease suddenly becomes epidemic in a given district; it seems to be contagious, but there is doubt as to its identity and uncertainty as to the possibility of its spread. The epidemiologist, by noting the way in which the cases occur may trace a relation between them which gives the clue to the situation. This is a common case. The epidemic behavior of a disease is often the only means of diagnosing it.

The higher work of epidemiology includes the discovery of new facts, the classification of existing knowledge and the formulation of a body of principles, practices and doctrines for the information and guidance of those who wish not only to suppress disease but to prevent it. At present much of this material must be ferreted out of works of reference to other subjects, particularly bacteriology, where it obviously does not belong. It is time that epidemiology was set upon its own feet.

Finally, epidemiology must be taught in medical schools and elsewhere. There is an immense amount of educational work to be done in teaching people the simple and well-ascertained things which they should know in order that they may not be in danger themselves or a needless source of danger to others. The largest field for epidemiologists is on health boards. In all branches of epidemiological endeavor a promising field lies open for the well-trained and adaptable worker.

The Function of Prophecy.—It is one of the functions of epidemiology deliberately to seek to foretell the future. This it does largely through the aid of statistical methods. The process appears simple, but it is not always easy of application. If a disease has for a long time become prevalent at certain intervals of years it is not difficult to calculate when it may reasonably be expected again. And the behavior of an epidemic of a given disease, like influenza, being well known from visitations in the past, it is not hard to forecast the course which it will take when it again bursts out. Soon after the start there is first an increasing rate of increase in the number of new cases per day; this is followed by a fairly steady rate of increase; there is then a rapidly decreasing rate of increase to the acme, or peak, or maximum daily incidence. The disappearance of the epidemic proceeds in the reverse order; there is an increasing rate of decrease followed by a fairly uniform decline and the epidemic comes to a conclusion after a period characterized by a decreasing rate of decrease. When plotted as a curve, the characteristic epidemic picture is bell-shaped. The proportions vary somewhat for different infections. In influenza the bell tends to become an inverted V; in typhoid it is longer and lower. Knowing the disease, it is sometimes possible to

anticipate the time of greatest prevalence, the period of decline and the end, with considerable accuracy.

Again, pandemics follow travel routes; and knowing these routes, the direction from which to expect the disease is disclosed. For example, knowing definitely the channels of infection, as is often the case in epidemics due to infected milk, it is possible to foretell what persons are in danger of being attacked, where to employ special precautions and where to look for fresh cases.

It is unnecessary to pursue this point. And yet there is one more service in the foretelling of events which epidemiology can perform, and one which has not received the attention which it deserves. This depends upon the observation that epidemics often plainly announce their coming beforehand. Thus, before the great typhoid epidemic at Ithaca there were lesser epidemics of gastro-intestinal disease in the city each year for many years. Before the 1918 pandemic of influenza-pneumonia in America there were minor epidemics of influenza; these in turn were preceded by epidemics of more common respiratory infections. In view of the great number of instances of this kind which could be cited, it is scarcely too much to say that great visitations of disease oftentimes throw out danger signals long in advance. It is for the epidemiologist to watch for these things, to translate their meaning into terms which others can understand and to secure suitable action upon them.

The Practitioners.—The field from which epidemiologists of the right measure can be obtained is limited. To most persons the word "epidemiology" conveys the impression that there exists in definite and serviceable form a body of facts, principles and practices concerning the spread of transmissible diseases. With this impression it is natural to assume that skilled practitioners of this science exist. By implication, an epidemiologist is one who is familiar with the best methods of investigating the causes of disease and with the procedures which it is necessary to take in order to keep infections reduced to their lowest terms. It is easy and reasonable to think of an epidemiologist as one who follows a definite calling, one to whom the hidden causes of infections stand revealed and through whose efforts the extension of disease can be checked.

Unfortunately, epidemiology is an undeveloped science and skilled epidemiologists are few. The subject has no collected literature of its own, no fixed methods of research. There are few teachers in the schools and colleges. There are no legal or scholastic requirements for admission to the ranks of its practitioners. At present epidemiology is not a profession or calling which is followed for itself as is medicine, engineering or bacteriology. It is almost invariably an incidental pursuit, taken up vicariously, occasionally and by force of circumstances.

Those who are most competent to do epidemiological work seldom speak of themselves as epidemiologists. The practitioners are usually physicians, bacteriologists, health officers, sanitary engineers or

statisticians. Any one who professes an interest in epidemic diseases may style himself or be styled an epidemiologist, without fear of successful contradiction, but there are few whose accomplishments warrant their use of the term.

It is natural to think of epidemiologists as persons who are able to stop epidemics as well as investigate them, but this assumption is generally unwarranted. In this field, as in others, the ability to know does not imply the capacity to do. To know what steps to take in order to prevent meningitis, for example, it is necessary to know the connections by which the virus passes from person to person, but to stop an epidemic of this disease it is necessary to do the things which will make those connections impossible. Steps must be taken which will so interfere that the virus will fail to reach its mark. To initiate steps which will prove effective, and not at the same time too seriously disturb the vocations and avocations of those among whom the work is done, calls for a high order of practical ability.

It so happens that the investigation of epidemics is a fascinating, scientific occupation, while the practical work of handling them is laborious and dangerous. All epidemics are investigated after they have broken out, and most of them after they have subsided. On the other hand the work of stopping them should be done promptly and at the fist sign of danger. Unfortunately this practical work is generally undertaken too late. The fire becomes a conflagration before the firemen get to work. Most epidemics stop, not because any one stops them, but because they exhaust the inflammable material or cannot reach it for natural reasons.

The qualities required to stop an epidemic are those demanded of an investigator and more. The epidemic fighter must be a man of action as well as of thought. He must not only know what to do, but how to do it. It is impossible to place too much emphasis upon this capacity to do. People must not alone be told; they must be shown. It is useless to talk of isolation and disinfection, of quarantine and physical inspection, if ways cannot be found for carrying them out. Usually only simple things are needed. It is imperative that everything be done well. The whole success of anti-epidemic work depends upon the excellence with which it is done. The measure of excellence lies in the efficacy of the procedures when compared with the inconvenience which they entail.

Epidemic fighting may be regarded as a branch of epidemiological work although the term epidemiology, as usually employed, has much less relation to practice than to theory. Measures intended for preventative purposes, and corrective ones, are not commonly supposed to fall within the scope of epidemiological work.

The Proper Conception of Cause.—It is desirable to define clearly what is meant by the word cause in epidemiology. There are two ways of looking at this matter. We may consider the phenomena of infection as it relates to the individual or we may regard the subject in the broad aspects of the collective presence of disease.

When individuals are concerned the search for the cause proceeds intensively and along relatively narrow lines. The character of the work makes it necessary to enter considerably upon the fields of bacteriology and immunology. Studies of this sort usually have particular reference to the detection of the immediate and most detailed causes. They especially seek to establish facts and principles which can be applied in insuring the safety of persons by increasing their personal resistance and by showing wherein personal danger lies. Thus, the investigation of carriers as sources of typhoid calls for intensive work of a very particular character. The biological behavior of the infective host assumes a relatively predominating importance. The manner in which the virus passes from person to person, although a part of this study may not be of so much interest as the behavior of the virus in the body. Its capacity to live and retain its virulence while making the transit from person to person is a special study.

Under some circumstances the cause of an infectious disease is considered to be simply the virus itself. Thus, the cause of tuberculosis is said to be the bacillus of Koch. This conception of cause may be said to be the bacteriologist's view. The epidemiologist's conception of cause has as much to do with the means of transmission as with the germ itself.

When the phenomena of infection as it affects groups of individuals are under consideration, the idea of cause is still broader. The cause conceived is more particularly the route or channel by which the virus reaches those who become sick. From this point of view the cause is not the infecting organism so much as the means by which it is transmitted. Examples can easily be cited—a sewage-polluted water supply is said to be the cause of an outbreak of cholera. Similarly, louse-infestation may be said to be the cause of typhus.

There seem to be three separate and distinct points of view here, but in truth the three are but parts of a single large problem. To really understand how disease spreads it is necessary to know the focus, the virus, the routes by which the virus passes from person to person and how it behaves after it reaches its host. And it is in proportion to the completeness and exactness of this information that the epidemiologist's knowledge is trustworthy and useful.

It is often difficult, in particular instances, to discover exactly the way in which the virus from one person has been able to reach others, but it is generally easy enough to make a serviceable guess at it. The surmise is based largely on general principles. The guess is likely to approximate the truth in proportion to (*a*) the definiteness with which the general principles which apply have been worked out for the particular disease in question and (*b*) the completeness with which the observed facts agree with those principles. The principles have been well established for some diseases and hardly at all for others. For typhoid, for example, they appear to be completely fixed. Consequently, it is often practicable to show every step which is responsible for a typhoid outbreak with the finality of a demonstration.

To illustrate, the stools from a typhoid patient are thrown, without disinfection, into a water closet whose sewage is later found to leak from a broken underground pipe into a well. People who drink from this well become sick with typhoid; none who do not use this water are attacked. No better proof is needed to show completely the cause of this epidemic. Every step in the progress of the germs from their focus in the intestines of the sick to the intestines of their victims is thoroughly demonstrated. Such complete proof is the ideal toward which every epidemiological investigation should aspire.

What has been said here has had reference to the specific causes of epidemic diseases and of epidemics. An effort has been made to make the remarks as brief as possible, but it is hoped that enough has been said to make it clear that our conception of cause should be as definite as possible. The cause of an epidemic is not simply the virus, or the means of transmission, or the susceptibility of those persons who are attacked, but all these factors taken together. The outbreaks could not occur if any of them were missing.

Types of Outbreaks.—It is sometimes convenient to speak of an infectious disease according to the extent or manner of its occurrence. It may be endemic, epidemic or pandemic—or sporadic. There is no exact definition of any of these terms, but there is a general agreement as to their meaning which it is well to bear in mind.

A disease is endemic when it is more or less securely rooted in a region. It may or may not be prevalent. Usually only a few cases occur from time to time. Often its presence is scarcely noticed except at periods when it breaks out with more or less violence. If the disease does not occur as an epidemic or otherwise possess sensational features, it may continue to exist unnoticed indefinitely. Cases which occur occasionally here and there are sporadic.

When a disease is endemic its type is often notably mild. Not infrequently the name is unknown locally. Its presence, if not taken as a matter of course, is commonly regarded as inevitable. From the epidemiological standpoint endemic disease is smouldering disease. The cases are embers kindled from past fires and ready to break out again on suitable occasion.

Endemic infections are of the utmost interest epidemiologically. From time to time most diseases which are ordinarily endemic assume larger proportions. They gain in severity. They spread into epidemic form. Something fans the smouldering sparks. What it is that does this is one of the mysteries of epidemiology. In investigating the history of an epidemic it is always desirable to consider the endemic history of the locality.

Disease is properly called endemic, when, in spite of such precautions as are taken to prevent it, individual cases and sometimes local outbreaks take place. All the great pestilential diseases are endemic in certain parts of the world. Typhus is normally endemic in the Near East, plague and cholera in certain parts of China and India, yellow fever in Central America, South America and the west coast of Africa.

Typhoid, which is a genuine pestilential disease and the last great filth infection to be banished from civilized communities is endemic throughout the western world. Smallpox, scarcely dreaded now where vaccination is practised, is nevertheless, widely endemic nearly everywhere.

It is reasonable to suppose that if the endemic foci could be discovered and extinguished, epidemics would no longer be possible. Work toward this end is a common procedure. Its object is usually to protect particular cities and towns. Improved water supplies and drainage systems have this object in view. Sometimes the area to be protected is much larger. Efforts are now being made to exterminate yellow fever utterly. Economically considered, endemic infections are of the utmost importance.

The spread of pestilence is often slow and insidious at first. In its last great visitation, cholera was prevalent in India for fourteen years and had obtained a footing in Europe for two years before it made its appearance in England. Thereafter it was a constant menace to the British Isles for thirty-five years. Before it disappeared it had swept away many thousand lives.

It often happens that several diseases of a given type go hand in hand. This fact helps to obscure the situation. Epidemics of diarrhea have sometimes preceded and followed epidemics of cholera. During the pandemic of influenza in 1918, other respiratory diseases were prevalent.

Disease may spread to considerable proportions before its prevalence is recognized. Often the first sign of trouble is an excessive fatality in some public institution such as an orphan asylum, jail or workhouse. A sensational outbreak then occurs. While only occasional cases were being reported the infection was gaining a firm foothold.

The opposite of an endemic disease with its continual small prevalence is a sudden outbreak.

A disease is said to be epidemic when it is generally prevalent. It is pandemic when it almost universally prevails over a large territory. The area over which the prevalence occurs, the rate at which it spreads, its intensity (that is, the proportion of persons attacked to the number of those exposed), the duration at any place, the tendency to establish new foci, the degree to which the disease attaches itself permanently to a locality, and the rate at which it travels from one point to another are matters of considerable interest to the epidemiologist.

A sporadic outburst is one in which scattered cases occur in point of time and place where the disease has not been endemic.

With the conception of an epidemic always comes an idea of a definite place or group of people wherein the disease occurs. It is not the total number of cases so much as the number in some particular locality that is of consequence. Thus, there is a natural inclination to attach significance to the place or the immediate circumstances surrounding the outbreak.

Epidemics are often composite phenomena and in order to understand them it is sometimes desirable to try to separate them into their component parts. A city epidemic may be made up of neighborhood epidemics and a neighborhood epidemic of household epidemics.

How the separation can be made will depend upon the disease and the type and location of its centers. In outbreaks of cholera in which the original focus is the general water supply, the disease is sometimes kept going a long time through the establishment of secondary foci, such as milk supplies, which become involved after the first wave of infectious material has passed by. In most diseases each case should be regarded as a potential focus which may lead to other cases in the vicinity.

The Nature of Proof.—We are now prepared to consider the four criteria which must be satisfied in order that a case, or a group of cases, of infectious disease may be perfectly connected with their source:

1. There must exist a human source of the infective virus. Strictly speaking it is not sufficient in explaining how a man contracted malaria to say that he lived where there were mosquitoes, nor, in fact, even to say that the mosquitoes were of the anopheles variety. The mosquitoes in this case merely represent the means of transmission. We must look for some person or persons who possessed the malarial organisms in the blood. It is often impossible to find the person who was the original source of the virus and in this case it is enough to show that there were a number of infected persons to whom the mosquitoes could have had access and so secured the virus which they later inoculated into the persons who became sick.

2. Means must exist whereby the virus can pass from its source to the individuals who are attacked. The necessity for this second link in the chain of proof is generally recognized; it is often, in fact, the only one of the four criteria to which much attention is paid. The existence of the first is often assumed. Thus, if an epidemic of typhoid apparently results from the drinking of a certain spring water, it is seldom thought necessary to find out how the spring came to receive its infectious material. It is necessary, of course, if the whole cause is to be worked out.

3. The existence of the source and means of transfer must agree in point of time with the date of infection. The time factor is of some consequence, since the virus of most infectious diseases is rapidly destroyed outside of the human body and is seldom known to cling about any place or thing for a considerable interval of time. Under some circumstances it is true that there seems to be a prolonged interval between the escape of the virus from its human source and the cases of sickness to which it leads, but it is doubtful whether such extraordinarily long periods exist as are commonly supposed. It is desirable for the epidemiologist to look for relatively short and direct means of transfer.

4. The nature of the proof which connects an outbreak with its

cause must be such that a preponderance of facts is in agreement with the conditions which theory shows are necessary and no single fact is in opposition to it. We are here considering the question of logic and of that branch of logic which has to do with inductive reasoning.

The method of inductive reasoning which is so much employed in epidemiology is full of peril to the unwary, but rightly used and with a sufficiency of material to work on, it is capable of the most useful results. In epidemiological investigations, deductive as well as inductive logic is frequently employed. The inductive process is necessary in order to establish the grounds for the formulation of a theory. The theory formed, the deductive process begins and the consequences which follow are reasoned out.

It remains to point out that a number of predisposing and aggravating conditions may contribute materially to cause infection and that the epidemiologist must be constantly on his guard against placing too much importance upon them. Frequently it is the circumstances which favor the spread of disease, instead of the conditions which actually produce it, which satisfy the too hasty investigator.

It is only necessary to name some of the conditions which favor the spread in order that their harmful influence may be appreciated. The entire category may be mentioned in a general way together, as follows: Filth, disorder, poverty, ignorance, neglect, carelessness and indifference. None of these can be said actually to cause disease but they certainly favor it. Where they occur disease is likely soon to follow.

The Two Main Elements of Infection.—Among the many elements to be taken into consideration in the study of epidemiological questions, there are two of paramount importance: the behavior of the infective virus after it reaches its host and the action of the body which is attacked. It is the contest between these two great forces which constitutes the phenomena of disease.

Both of these forces vary widely. The virulence of the infective agent is not always the same by any means. One kind of virus differs from another in virulence and there is much variety in the virulence of the same virus under different circumstances.

Two main classes of infective poisons may be considered, those in which the virus increases in the body and has its sole existence there, and those which can live for a considerable time outside the body, as in water or milk, or some other inanimate substance.

A virus is not necessarily harmful to the host which it inhabits. It may carry on a saprophytic existence without producing any visibly ill effects. Carriers of typhoid, diphtheria, meningitis and other diseases afford examples of this kind. On the part of the host, susceptibility to infection varies not only with respect to the virus of different diseases but in many other respects.

Sometimes the variables which affect virulence and susceptibility work together so that infection takes place so spontaneously as to possess all the clear and connectible features of proof. Sometimes they take opposite directions, in which event there is complexity,

delay and either an unusual form of infection or none at all. It is probable that a typical case of an infectious disease is contracted only under those exceptional conditions wherein the circumstances all work favorably toward the one end.

With relation to the virus, the following deserve to be taken carefully into account: The kind of infective agent, its type, means of transmission, amount present, nearness to the susceptible material and the repetition of the attack of the virus.

With relation to susceptibility there are two sets of factors which deserve consideration: Those which contribute to infection indirectly as extreme fatigue, hunger, cold and mental stress, and those which react directly as immunity, natural or acquired, partial or complete. These last may result from inherited qualities, from a previous attack of the disease, from an immunizing process purposely employed, or from physiological conditions most of which are not yet understood. Their duration varies. In some diseases immunity is first acquired by an attack and then lost after a more or less prolonged interval of time. Persons who are apparently not susceptible to relatively small doses of infective virus may succumb to large doses. On the other hand, immunity may be accidentally acquired by continued exposure to small doses of virus, so that eventually, relatively large doses may not produce an attack of sickness in a person who would otherwise be susceptible. As an example, it is due perhaps to this relative immunization, accidentally brought about by repeated small doses, that city people are less susceptible to the respiratory diseases than are people fresh from the country. Further, the extreme susceptibility of the eskimos and of savage tribes to measles and smallpox, has been ascribed to the fact that these aboriginals were not accustomed to the infective powers of these diseases. Not only is disease more likely to be contracted by people who have never been exposed to it before, but the severity of the attack is likely to be greater among those who have lived in a region where the disease in question is rare or unknown, or in other words, the more common the disease, the more mild the attack. Smallpox, for example, is a well nigh universal, but a relatively mild disease in Mexico.

Among the indirect factors which affect the risk of infection are weather and climate. These two elements may produce a direct effect, as when they alter the amount and character of the excretions, or they may give rise to indirect effects as when they lead to crowding and to indoor life in general. Again the indirect effect of climate and weather has to do with clothing, especially with reference to its adequacy in protecting the body against cold. Food, especially with reference to its quality, quantity and composition is believed to play an important part in influencing the immunity which persons may exhibit toward infection. Fatigue is generally supposed to favor infection, especially when the fatigue is excessive and continual. Hygiene, especially with respect to body cleanness, has an obvious relation to the possibility of infection.

It is proper to say that there is a school which holds that immunity is a very specific and definite condition and that so-called predisposing and aggravating factors play but little part in it. According to this theory such elements as hunger, cold, fatigue and the stress and strains of ordinary life produce little consequence. What seem to be variations in susceptibility are really irregularities in the behavior of the virus or in its ability to find a suitable point of attack. The advocates of this belief are inclined to insist upon experimental data to support whatever claims are made in the science of infection.

It must be admitted fully that the subject of infection cannot be set forth with the definiteness of a geometrical diagram. There is much about disease which is speculative and inexact. The science of immunology is in its infancy. Until there is an abundance of thoroughly established facts and principles, to substitute for the apparently justifiable beliefs which practical epidemiological research has adduced, it would seem that a wise course would be to give some weight to the probabilities.

It is not always possible to say, therefore, exactly in what way and to what extent the various factors which make for, or tend to protect against disease, are able to operate in addition to the virus, but that they may have a powerful if subtle effect, is the opinion of a large majority of epidemiologists.

The Relation between Virulence and Susceptibility.—A number of conditions are necessary in order that a virus may make a successful attack: (1) The virus must possess a sufficient degree of virulence; (2) it must be present in sufficient amount; (3) it must make its invasion by an appropriate avenue; and (4) it must succeed in reaching susceptible tissues.

The particular place where a virus makes its attack is called the primary focus. The focal infection, therefore, is the original point of infection. The point of invasion or inoculation may or may not develop into a focus. It does not do so in typhus but it commonly does do so in wounds.

The secondary infection may be by a different type of organism or by the same one. In epidemiology, it is wrong to speak of secondary infections as meaning new cases which are attributable to those due to the original cause of the outbreak.

There are five main portals of entry by which infective virus can establish itself in the body and so cause infection. The five follow:

1. The alimentary canal or more strictly, the upper opening of this canal: the mouth. In this instance the virus enters generally with food or drink. The focus of infection is usually established beyond the stomach.

2. The respiratory tract, or more accurately, the nose and mouth. The virus generally enters from the atmosphere during breathing, but it may be taken in from the hands, conceivably with food, or from articles temporarily put into the mouth. The focus of infection may be the tonsils, the nasopharynx, the lungs or other parts of the breathing apparatus.

3. The skin, as when the surface of the body is abraded.

4. The blood, as when infection takes place by suctorial insects. The focus of infection in this case, may be at the point of entrance, as with most wounds, or in the blood stream, as usually occurs in the case of insect bites.

5. The genital organs. The focus of infection is the mucous membrane.

The body possesses certain normal defenses against infection. These barriers may be regarded as of two principal types; those which are exterior, or mechanical, and those which are internal or biological.

The skin is an exterior obstacle of the most substantial character. Its effectiveness is believed to be due largely to the existence of its epithelial cells. Their texture and thickness vary greatly and are suited to offer resistance in proportion to the local need under ordinary normal circumstances. Included among the mechanical defenses, must be named certain liquid and other discharges which perform the office of scouring and flushing away potentially harmful virus. Included among those useful substances are the saliva, sweat and excretions.

The biological defenses include the entire group of blood and serum reactions. These possess bactericidal powers and are the body's last defenses against attack.

It is possible to express the two elements of virulence and susceptibility which together produce infection as algebraic quantities and the phenomenon of contagion as an equation, thus:

$$V + S = I$$

In this equation, V is the virus, S the susceptibility and I the infection.

Now, from this equation, it is evident that if either the virus or susceptibility increases, the infection will increase also; and conversely, a reduction of the virus or susceptibility will lead to a reduction of the infection.

By transposition:

$$S = I - V$$

In this case, susceptibility may be conceived as equivalent to infection minus virus.

Finally:

$$V = I - S$$

Here the virus is represented as infection minus susceptibility. This may be said to represent the carrier state.

The Interrelation of Infections.—Whether the existence of one disease favors or tends to protect against infection by another is a point of much interest to the epidemiologist. It has sometimes been supposed that two of the acute infections are incapable of existing in the same person at the same time. This is not true. There are

numerous instances to show that two or more can occur simultaneously. There is evidence to show that in certain instances organisms of different types can make a successful attack where those of a single type are unable to gain successful lodgment.

It is probable that no general statement can be made which will cover the entire case. Pneumonia generally follows a milder respiratory infection; typhoid fever, on the other hand, frequently attacks persons not only in the prime of life but at the height of physical perfection.

It would appear that certain microörganisms are able to invade the tissues of the body through the healthy mucous membrane, and there is reason to believe that intestinal diseases may find a footing without any previous impairment of the digestive tract. Exceptions to this rule occur with respect to the pus-forming organisms, the existence of which upon the surface of the body is well known to be common in health.

How to explain the manner in which pathogenic organisms long resident in the mouth and throat produce infection is by no means clear. By some it is thought that infection occurs during a temporary injury to the mucous membrane produced by a sudden and temporary alteration in atmospheric temperature by which a congestion is brought about; others believe that the germs may gain entrance through minute and undiscoverable injuries. Many hold that there is a direct penetration possible even through the healthy tissue. With these general remarks the subject will be left to the immunologists.

Some diseases convey lasting, though not necessarily permanent immunity. Instances follow: Cholera, typhoid, typhus, scarlet fever, measles, smallpox, chicken-pox, yellow fever, mumps, poliomyelitis and syphilis. A second attack of typhoid, of scarlet fever, or of syphilis or mumps occasionally occurs. Lasting immunity is not produced by an attack in the following diseases: Beriberi, dengue fever, diphtheria, erysipelas, gonorrhea, glanders, pneumonia, recurrent fever, tetanus and tuberculosis. In some diseases, as malaria, reinfection appears to be impossible so long as the individual harbors the microörganism.

Relatively few diseases are transmissible from the lower animals to man or the reverse. Tuberculosis of the human type is probably never infective to cattle, horses or sheep, dogs, goats or birds. On the other hand, the bovine type of tuberculosis occasionally infects man, but this is exceedingly rare except among children and then the infections are chiefly abdominal or involve the cervical lymph nodes. The tuberculosis of birds and cold-blooded animals is not transferable to man.

Among the diseases which occur in man only are cholera, diphtheria, gonorrhea, influenza, leprosy, measles, typhoid and typhus, scarlet fever, smallpox, poliomyelitis and yellow fever.

Among the diseases which occur not only in man but in other animals are the following: Glanders attacks horses and mules and

sometimes sheep, goats and camels. It is essentially a disease of animals to which man is also susceptible. The only domestic animals which seem to be immune are cattle and rats. Pneumococcus infection is virulent for rabbits, mice and guinea-pigs, but relatively harmless for rats, dogs, cattle and sheep. Anthrax, like glanders, is a disease of animals to which man is liable. Guinea-pigs, rabbits and white mice are very susceptible; rats, horses and dogs are relatively resistent. Tetanus occurs in man, cattle, horses and sheep and is rare in dogs and goats.

The Classification of Diseases.—Although it is impossible to reduce all the infectious diseases to a brief and comprehensive system of classification, it is practicable to gather the more usual ones into groups, based upon the possession of more or less common features. The most usual basis for this grouping is the kind and degree of their infectivity.

Contagious diseases are those which are so easily transmissible that the mere presence of the sick is sufficient to cause others to become ill also. Measles, rubella, scarlet fever, smallpox, varicella and mumps are in this group. Little or nothing is known about the virus of these diseases; how it leaves the body, how it enters, or what it consist of. It is generally assumed that it is microbic but its behavior in the body and out of it are questions which have yet to be put on a definite basis.

In spite of this lack of knowledge, there are many facts of value regarding the epidemiology of the contagious diseases. All of them occur endemically and sometimes epidemically; all vary considerably in the severity of their cases and in different outbreaks; all are more prevalent at some seasons than at others; all are difficult to diagnose at first; all occur under circumstances which make it impracticable to suppress or prevent them; all are crowd diseases; all are liable to complications and sequelæ which add materially to their fatality. They differ among themselves in prevalence, in severity, in duration, in infectiousness, in incubation period and in various other respects.

The contagious affections are crowd diseases in the sense that their occurrence is greatly favored by the crowding of human beings, especially in respect to their dwelling places. Some of the diseases mentioned as erysipelas, for example, are most common in overcrowded hospitals. Others, such as scarlet fever and measles, seldom become truly epidemic except in institutions or schools. In some way not perfectly understood, the density of the crowding seems to be related to the probability of attack. Rubella or German measles is much more uncommon than measles, which it somewhat resembles, and is seldom seen except in epidemics. Scarlet fever is not only highly contagious but is not infrequently carried by a third person and by objects. Whereas measles and rubella are contagious chiefly at the beginning, scarlet fever is transmissible throughout the attack and in some instances long after apparent recovery.

It is often difficult at first to distinguish between measles, rubella and

scarlet fever except for the epidemiological evidence, such as proof of exposure to other cases and period of incubation. The chief difficulty in controlling the contagious diseases lies in discovering them in time to carry out the measures of prevention necessary. These measures almost invariably consist of isolation in some form.

The purpose of isolation is to interpose some obstacle between the source of the infectious matter and those persons who are believed to be susceptible to it. This obstacle may take many forms. Quarantine is an example of it, as are special hospitals, the use of cubicles and masks and the separation of persons as much as practicable within the sleeping and living quarters which they must occupy. The degree of isolation which is necessary and sufficient for the prevention of infection varies with the different diseases.

A second class of infectious diseases includes the active respiratory infections. In this group are the ordinarily unnoticed but important common colds, and bronchitis, laryngitis, influenza and pneumonias. So prevalent and so fatal are the pneumonias that they deserve to be considered separately. It is probable that meningitis should be included in this class and possibly poliomyelitis also. Diphtheria and tuberculosis although infections of the respiratory type are not so distinctly contagious as some of the other diseases mentioned.

The chief difficulty in the way of controlling the respiratory infections lies in the apparent mildness with which they begin and the seemingly disproportionate amount of trouble which the preventive measures entail as compared with the necessity for them. There is this fundamental obstacle also: it is the affected person who must exercise the precautions whereas it is the others who are in danger of contracting the disease. People can do little for their own protection.

A third class of diseases comprises the intestinal infections. In this list are the infectious diarrheas, typhoid fever, cholera and dysentery. Although they sometimes offer difficult problems of diagnosis, the better knowledge which exists concerning their microbic causes and their means of transmission by water and food add materially to the facility with which they may be recognized as compared with the contagious diseases in the two groups already mentioned. The first obstacle to suppression of infections of this type lies in the necessity of keeping food and water free from contamination with human excrement. All the infectious diseases could be exterminated if the infectious material which produces them could be destroyed at its source of origin. This can be more readily done with the infections of the intestinal type than with any others.

There is a long list of diseases which are communicated by insects. Among the commonest members of this group are plague, yellow fever, malaria fever, typhus fever, trench fever and relapsing fever.

Finally it remains to mention here a class of infections which differ from the foregoing groups by reason of the fact that the extension is more particular. Wound infections and venereal diseases are

examples. The site of inoculation and the nature of the virus are generally understood. Prevention lies in the practice of asepsis and disinfection at the site of inoculation.

Common Vehicles of Infectious Material.—The virus of disease seldom passes from person to person by actual contact. It does so in the case of venereal diseases but not often in any other infection. As a rule the material is transmitted by some exterior agency. This agency, whatever it is, is called a vehicle of infectious material. If the passage is very short in time and space, the infection is called contact.

In respiratory infections the most common vehicle is probably the air. Sometimes the germs are thrown out to the air direct, as by sneezing; sometimes it is present with dust from floors, bedding or other objects which have accidentally become infected. When the atmosphere thus becomes charged, it is consequently dangerous. Theoretically and practically the danger increases much more rapidly than the distance from the patient decreases.

Over what distance infection can occur through the air probably depends upon the amount of virus in it. This in turn depends upon the fineness into which the minute masses are divided and the weight of these ultimate particles. If the air was still they would quickly subside, but the air is never perfectly quiet. The infective material remains suspended for the same reasons that dust is suspended and its movement follows the same laws which apply to the aërial transmission of dust. If this is true, there is here an explanation why the aërial transmission of disease is always short—there are few authoritative cases in which it has been known to extend beyond the room in which the patient has been confined. Badly ventilated barracks, hospital wards and other inclosed spaces, even though large, become charged with infectious matter because it is not only produced but confined there. Ventilation affords one of the most useful means of preventing aërial infection for it provides both for the dilution of the poison and for its removal.

It is perhaps unnecessary to say that air-borne diseases belong chiefly to the respiratory type and that the cases which develop are usually sporadic.

Water, milk and other beverages commonly act as vehicles for the virus of intestinal infections. These liquids no doubt often receive the germs of respiratory diseases, but it is not known that they ever lead to respiratory infections.

Water becomes contaminated generally through pollution by the drainage of some receptacle of human excrement. Milk most often becomes polluted through impure water and by the hands of milkers. The type of outbreak produced by milk or water is generally explosive. Infection by water may, however, be sporadic. Many cities with polluted water supplies have continuously high typhoid rates.

Food sometimes leads to infection, but in view of what it would seem reasonable to expect, it is surprising that so few instances of

it are on record. It would seem that bread and fruit as well as other articles of food which are sticky, handled a good deal and often in a position to be coughed upon and eaten without subsequent cooking must frequently serve as vehicles of infectious material.

Common objects, familiar to everyone, handled by everyone, help to spread diseases by serving as temporary storage points and exchange places for microbic poisons. These objects include door-knobs, the arms of chairs, pencils, car straps, dirty towels and drinking cups. Whatever is very near to the person who is coughing and sneezing germs into the air probably becomes contaminated.

The hand plays a prominent part in the spread of disease. Its structure and its functions perfectly suit it for this office. Commonly the germs get upon the hands directly from the excretions and these microbes are then transferred to articles which gain entrance to the mouth.

The part which insects play deserve notice. Some diseases, as typhus and malaria, could scarcely occur without the intervention of insects. The common house fly has been charged with spreading typhoid but aside from its probable complicity in special instances, it is doubtful whether it is as guilty as it is made out to be.

Briefly then, the vehicles which transmit infectious matter are various and their effectiveness in causing disease depends upon the ways in which the germs are thrown off from the body and the way in which they must enter it. Respiratory diseases are probably most often transmitted by the air, intestinal diseases by food and drink and infectious diseases of the blood through the skin by insects and wounds.

Tabulations and Graphs.—Under the heading of Methods and Resources, it was pointed out that the foundation of all epidemiological work was the collection of facts. It was stated that these facts must be gathered with the greatest care, that they should be of proved accuracy and that it was necessary for them to be properly arranged in order to yield the maximum of information.

Much will depend upon the arrangement of the collected data. A carefully considered system of tabulation should be devised in order that the very bulk of the material may not obscure a clear view of the conditions which the data represent.

The elements which are most commonly represented in statistical studies as, for example, an epidemic of a particular disease, are the location of the cases, the duration of the outbreak, the total number of cases, and the fatalities and various details relating to these elements. By the proper arrangement of the data may be discovered the concentration of the infections within geographical and time limits, the direction and rate of spread and many other points of interest.

It will generally be found best in the long run to prepare many relatively small tables rather than a few large and concentrated ones. Groupings and regroupings should be made in order to see what facts these combinations reveal. The clerical work should be

done with great neatness; the typewriter and every other mechanical aid should be employed. Large numbers of figures should be separated by spaces rather than lines. Complicated headings should be avoided; lines of figures should be divided into groups of five to aid the eye in following the lines; the data should be worked up as fast as it is collected and not left to some future date for study.

In studying a large map of data, it will often be desirable to make use of diagrams. One class of graphs may have to do simply with the illustration of the tabulated data. Another will have for its object the analysis of the tabulations. Tabulations should always be made as the basis for diagrams.

Spot maps are convenient as a means of visualizing certain facts which cannot well be comprehended otherwise. A spot map is simply a large-scale map upon which locations, as the position of cases, are suitably marked. The most simple system of marking is to stick a pin into the place where each case has occurred. Colored pins, especially made for such purposes, are obtainable; the color indicates the character of the disease or its fatal consequence or its recovery. This may show at once the centers from which other cases have radiated, or from which other cases may be expected. A development of this scheme is the employment of long pins, each of which carries a tag upon which various particular facts are compactly written as, for example, the number of the case, its date of onset, etc. A casual inspection of the map at once shows the distribution of cases and a closer inspection brings out many other points.

Epidemic curves are often employed in connection with spot maps. They can be easily and quickly plotted and they show the increasing or decreasing tendency of the outbreak every day or week. It is customary to plot such curves by using a horizontal scale to indicate the time intervals and the vertical ordinate, the incidence of cases or their rates. For this purpose standard section paper can generally be had at stationery shops, ruled to inches and tenths. The length of the smallest division of the horizontal and vertical scales must depend upon the conditions of the epidemic. The vertical scale should always be much greater than the horizontal; it should be great enough to emphasize the large variations without attaching undue importance to the little ones. It is advisable to make various plottings in order that the work when complete will be simple and impressive. It must not in any way be confusing or cramped; it will usually be worth while to have the work done by an engineering or architectural draughtsman.

Instead of the curves just described, it is often desirable to use a still simpler form of diagram. A series of lines or bars or columns represents the number of cases from week to week or day to day. These should almost always be drawn from the bottom up and seldom from one side of the diagram toward another. The diagrams may be made of a size suitable for wall display or for desk work. If for the desk or to accompany a typewritten report, the diagrams should

be the size of a sheet of letter paper, or twice that size and folded once. Unduly long, bulky, awkward or clumsy diagrams often defeat their own ends for they are too inconvenient to be examined.

Where feasible, it is well to have a small condensed table of data to accompany the curve or diagram. No graph is likely to be sufficiently accurate to permit figures to be taken from it. Graphs are intended to indicate general tendencies; resort should be had to tables for detailed facts.

Epidemic Fighting.—The best time to take arms against an epidemic is before it occurs. Under no other circumstances is the old adage more true that prevention is better than cure. In fact, there is often no cure for an epidemic in full career any more than there is for one of the cases of disease which compose it. It can often be prevented—it can sometimes be restricted—but once under way it can rarely be stopped short.

Epidemic fighting is a popular term which is applied to work intended to limit the spread of a contagious disease which has already broken out or is thought to be about to do so. It is a prime necessity that the undertaking be placed in competent hands in order that the campaign shall be well prosecuted. The work should be pushed with energy, directness and thoroughness. Ample authority must be given and pecuniary resources must be made available at the outset. It is highly important that wherever possible a laboratory for clinical and bacteriological control shall be available.

The details of much of the work of epidemic fighting will generally have to be attended to by persons of little or no training in this subject. In consequence of this fact only simple procedures whose principles can easily be grasped should be employed. It will often be found that the cause of the epidemic lies in a set of conditions the existence of which is not so much unknown as uncorrected.

A campaign against an epidemic should embody the following features:

(*a*) *Education.*—Every competent person available should be induced to coöperate in the work. Courses of action should be prepared for all those who are to assist in arresting the spread of the disease: physicians, nurses, housekeepers and all who may be in danger or may endanger others. Instructions should be given by lectures, and where feasible, in printed form. There should be no secrecy about the name of the disease, its character or its progress.

(*b*) *Notification.*—Cases, deaths and other data needed by the central authority should be specified by him and reported fully, accurately and immediately.

(*c*) *Isolation.*—The sick and other sources of the infective virus should be so dealt with in hospitals or homes as to make it as nearly impossible as may be for the virus to pass to those who may be susceptible to it. Efforts should be made to detect those who are immune by reason of a former attack or otherwise.

(*d*) *Vaccination.*—In those diseases in which artificial immunization is practicable it should be widely practised.

(*e*) *Inspection.*—It will be necessary to see if the lessons given in the educational campaign are being applied and it will be desirable to supplement those lessons. Inspectors possessing tact and practical ability will be needed to show how to do the things which are necessary and to report upon the condition.

(*f*) *Sanitation.*—Improved methods of cleaning and sanitating dwellings, streets, shops and public conveyances will strike a popular chord and will be beneficial in many ways.

(*g*) *Disinfection.*—By disinfection is meant the destruction of infectious material. It may be effected by chemicals, fire, sunlight or otherwise. Disinfection should be carried as near as possible to the source of the virus. It must be thorough—there is no such thing as partial disinfection. Properly employed, soap and sunlight are among the best disinfecting agents.

(*h*) *Investigation.*—The most useless thing to do in fighting an epidemic is to make an elaborate, scientific investigation of it. Sometimes, unfortunately, this is the only thing which is done. Investigations of one sort or another may be necessary from the outset, but these should be carried on for practical purposes only. The point should be kept consistently in mind that the work in hand is to limit the outbreak.

(*i*) *Report.*—The report is the last thing to complete but not the last thing to begin. Preparations for it should be made as soon as anything is done. By so doing the campaign will be kept in order, its various features will assume a just proportion and a correct perspective will be formed of the situation. All data should be tabulated, illustrated and digested as rapidly as it is collected.

In practical work of investigating and managing epidemics it often becomes necessary to know for how long after exposure a person may be in danger of attack. This interval is called the incubation period. It is not the same in all diseases nor in all cases. The fact that it varies with different diseases sometimes affords a useful clue to the diagnosis.

Apart from the minor respiratory affections, the shortest period of incubation among the contagious diseases occurs in scarlet fever. In scarlet fever the interval may be as short as a day or as long as a week; generally it is about three days. In erysipelas the interval is from three to ten days. Diphtheria generally takes from two to five days to develop but sometimes longer.

Measles has an incubation period of from one week to nearly three weeks; oftenest about twelve days. Rubella, or German measles, generally takes longer than measles to develop; ordinarily from two to three weeks.

The limits for mumps are usually ten and twenty days; for chickenpox from ten to seventeen days and for whooping-cough from one to three weeks.

Among the great epidemic diseases the shortest periods of incubation are: Cholera, two to six days; plague, two to eight days; and typhus, four to fourteen days. Typhoid may require anywhere from one to two weeks, sometimes more, and smallpox from eight to fifteen days, but usually about twelve.

With reference to the means of transmission, it is convenient to remember that practically all the diseases which one is likely to meet may be transmitted by contact and by carriers. Practically all may be conveyed for very short distances by the air. Among the diseases of the respiratory type, which are sometimes transmitted by food, should be included scarlet fever and tuberculosis and perhaps diphtheria and erysipelas.

CHAPTER VI.

SANITARY SURVEYS.

By W. L. DODD.

Sources of Information in General.—Two sources of information are essential in order to obtain an accurate picture of the sanitary conditions of a community. For convenience, these two sources of information may be outlined: first, a general picture of the community itself and, second, the factors affecting life wastage, together with measures for their control.

A historical review of the progress of sanitation within the community; commercial activities and their relation to public health, and a general description of the population, its composition and changes may be considered as coming under the first group.

Under the second group may be included such subjects as a study of the general death-rates; death-rates for specific causes; infant mortality, the public water supply, milk supply, disposal of excreta, problems of industrial hygiene, housing conditions, sanitation of schools, markets and streets, and the disposal of wastes and garbage. Beside the specific measures of conservation for the various factors just mentioned, there are general measures of control, such as the powers and duties of the Board of Health, the budget of the Health Department, publicity and education, drainage and mosquito control, rat eradication, and the removal of fly breeding places.

Historical Review on Progress of Sanitation.—A study of the progress of sanitation in a community is apt to reveal three distinct phases: the period when the individual alone was responsible for his own protection, the period when attempts were made by various individuals or organizations to introduce and maintain sanitary measures, and finally, the period when an organized Health Department came into control. Each of these phases should be carefully studied, together with their effect on the sanitation of the community.

History of Commerce and its Effect on Sanitation.—The effect of commercial expansion or decline may be illuminating, especially in the earlier days; progressive health measures being in vogue as long as prosperity existed, but abandoned with the onset of commercial inactivity. In port cities, the effect of quarantine on commerce should be noted, also the effect of commerce on quarantine.

Population Changes.—A study of the population should show the changes over the various decades with an indication of the effect of industrial enterprise on population movements. Observation should be made of changes in the composition of the population during the various decades by a study of the community according to the various main

color and nativity classes. Indications of an accelerated tendency toward Americanization might be shown by a growth of the native born of native parentage, accompanied by decreases in the foreign born or native born of foreign parentage. The general death-rates should be carefully studied with reference to population changes. An apparent acceleration of the total population growth might be due to marked decreases in the general death-rates and not to immigration. On the other hand, the general death-rates might be influenced by increases in race stocks with a known tendency toward high mortality-rates.

General Death-rates.—The study of the general death-rates may well be supplemented by a historical table of the principal causes of death in the early days of the community, thus making possible interesting comparisons between past and present tendencies in the mortality-rate. This study should include not only the principal causes of death but any marked seasonal mortality for a specific disease or group of diseases, bearing in mind that several factors may produce changes in published death-rates, such as changes in the classification of the causes of death, possible improvements in the diagnostic ability of physicians and the education of physicians to better reports and descriptions of causes of death, through the efforts of Federal, State and city registrars or statisticians. It is possible that high temperature may directly or indirectly affect the virus of smallpox with a lowering of the death-rates during the warm summer months. Harsh weather conditions may influence mortality-rates for various respiratory diseases. Diseases transmitted by the mosquito, as malaria and yellow fever, are affected by a lowering of the temperature and its attendant destruction or hibernation of the insects. It is also suggested that an examination of the general death-rates be made according to sex, race and age.

Before entering into a discussion of the present mortality-rates of the community, it is well to consider the effects of various sanitary reforms on specific diseases. For example, improvements in the public water supply or the method of sewage disposal might be productive of changes in the typhoid death-rates. The introduction within the community of specific biologicals, curative or prophylactic products, as diphtheria antitoxin or smallpox vaccine, would radically influence the death-rates for the respective diseases. The installation of an adequate system of drainage or the prosecution of a vigorous anti-malarial campaign should be reflected in the case and death-rate of the disease.

The present status of the community death-rates should be based on a study of the general mortality-rates, for a three-year period, according to color, sex and age. It is not wise to use figures for a single year in computing death-rates as the year may not be typical. Some unusual condition might be productive of a low death-rate or a severe epidemic might increase the death-rate above the average. Intercity comparisons may also be made, such comparisons being made with due regard to the composition of the respective communities according to color, sex and age. It is apparent that the death-rate of a com-

munity containing excessive amounts of children and young people with high death-rates from the communicable diseases could not be compared with a community made up largely of the middle- and old-age group with high death-rates from the degenerative diseases of adult life, unless the age composition in the two communities was stated or otherwise allowed for. In the same way, communities with large negro populations would have higher death-rates than those made up of the Caucasian race. Males have higher mortality-rates than females possibly because of a greater exposure to the health hazards of industry.

Other factors which may influence the death-rate may be social or economic in origin. Low wages and high living costs may be productive of poverty and a lack of proper medical attention and care. An inherited tendency toward a weakened constitution through successive generations of decadent and degenerative stock may also be considered.

Death-rates for Specific Causes.—The death-rates for specific causes should include the communicable diseases of childhood, tuberculosis, typhoid fever, pneumonia, malaria and any other disease which is a potent factor in the life wastage of the community. It may be well to consider death-rates for the degenerative diseases of adult life.

The first consideration in analyzing a specific death-rate, as that of a communicable disease, is a brief statement of the prevalence of the disease in the past and present, commenting on facts which have contributed to its introduction within the community, also whether the disease is increasing or decreasing in its incidence.

The crude death-rates may then be presented for a three- or five-year period in comparison with other cities, such comparison being made, if possible, on a basis of color and age although it must be admitted that it is difficult to obtain statistics on the distribution, according to color and age. Intercity comparisons of mortality according to sex and age of the total population are found on pages 16 and 17 of the 1911 Mortality Statistics Report of the Bureau of the Census and may be helpful especially where the age and sex distribution has not materially changed since the 1911 census report.

A differentiation between resident and non-resident deaths is also difficult to obtain for two reasons: First, because of an inability to obtain reliable data as to the fact of residence or non-residence and, second, because of the lack of an adequate definition of a resident. Some statement of the number of resident and non-resident deaths is indicated, however, where it is known that a large number of non-resident deaths occur in local hospitals or other institutions for the destitute and sick.

The death-rates for the particular disease under discussion may next be shown according to color, age and sex for a five-year period.

The reporting of cases by physicians may then be studied. As an example, select the death certificates of a reportable disease, as typhoid fever. For each death certificate a case report should have been recorded. The proportion of case reports filed to the number of known

fatal cases (death certificates) is an excellent index of the manner in which physicians are reporting. Furthermore a comparison of the dates on the case reports and death certificates is a check as to whether reporting is done within the prescribed legal limits, or as to the correctness of the original diagnosis. Case reporting is usually poorly done; so it is difficult to ascertain reliable fatality rates for diseases from Board of Health case reports. In a similar manner, fatality rates cannot be calculated from hospital returns because of the large number of moribund cases which they frequently receive.

It is well to examine the monthly records of case reporting for the communicable diseases and determine the possible occurrence of an epidemic indicated by marked increases in the case reports over what is considered as the normal average. Where the public milk supply is not pasteurized, the possibility of milk-borne epidemics of typhoid fever, scarlet fever, septic sore-throat and diphtheria should be borne in mind. Carriers or contact cases may exist for several of the diseases and be potent factors in distributing the infection.

Special attention should be paid to certain factors in connection with several of the diseases.

Difficulty will probably be encountered in obtaining figures to calculate rates for the venereal diseases and the discussion may limit itself to the consideration of the subject as a social problem in general and its control. Figures for syphilis, locomotor ataxia and general paralysis of the insane may be grouped and considered under one heading.

High mortality-rates for tetanus of the newborn suggest an inquiry as to the supervision and control of obstetrical service.

The health of food handlers, relation of flies and privies and the purity of water supplies should be investigated in the case of typhoid fever.

Malaria suggests a study of mosquito breeding areas, examination of the blood of individuals in infected districts and the screening of residences or other protecting devices against the mosquito.

Tuberculosis should be studied to ascertain whether there is a sufficient number of hospitals and sanatoria for advanced and incipient cases and whether visiting nursing service exists for the supervision of home cases. Dispensaries, open-air schools, housing conditions, the milk supply, medical school inspection, industrial dust and the educational work of tuberculosis associations are other factors for investigation.

Infant Mortality.—Infant mortality-rates cannot be accurately calculated unless there is accurate birth registration. Three methods of checking birth registration are suggested: First, birth-rates should not exhibit violent fluctuations from year to year. Second, birth-rates should not be markedly lower than the average birth-rate for other communities with similar color and age composition. Finally, determine whether the births were registered of all infants who died under one year. This necessitates checking back the death certificates of the infants in question against their birth registration cards.

Knowing the effectiveness of birth registration the infant mortality-rate can be calculated by color and for the various months. Infant mortality-rates may also be ascertained for the various quarters of the first year of life to discover at which quarter mortality is highest. It is well to subdivide the rates for the first quarter according to deaths under one day, of the first day, less than the first week and less than the first month. Considerable information for an infant mortality campaign may be secured if the infant deaths can be grouped into two series: deaths of infants caused by influences before birth and influences affecting the mortality-rate of infants following birth. A suggestion is offered in a classification which has been employed by Terry and Schneider distributing infant deaths according to prenatal and postnatal causes, the residuum being classified as due to all other causes.

The first group, prenatal influence, embraces deaths from prematurity, congenital debility, malformation and other causes peculiar to early infancy. The second group; postnatal influence, includes deaths from diarrhea, pneumonia, communicable diseases, other respiratory diseases, tuberculous affections, tetanus, and other postnatal causes difficult of classification. All remaining deaths are included under the third group,—all other causes. A careful study of infant deaths according to these various influences should indicate the methods and point of attack of an infant mortality campaign. The information is best obtained by case histories. The writer has used a somewhat similar classification: deaths ascribable to conditions preceding or at birth, and deaths following birth and largely attributable to environmental conditions. Curves plotted on the basis of the period when death occurred will show for "birth" causes a high sharp peak during the first few hours following birth, dropping away to a negligible factor within the first six months. On the other hand the "environmental" curve will show a gradual but slow rise during the first few weeks following birth with an abrupt rise by the end of the first month. The peak occurs in the second quarter of life, but is high in remaining quarters. In other words, the bulk of the "birth" deaths fall within the first month, after which "environmental" deaths become prominent. The plotting of two curves is more graphic and instructive than a single composite curve for all causes of infant mortality.

Several medical, physical and economic factors influence infant mortality, such as the character of the obstetrical service, the mode of feeding, the age of the mother, whether the pregnant mother worked before confinement and the wages of the father. Heat and humidity, the seasonal distribution of deaths and the home environment are very important factors to be studied.

Interesting comparisons can be drawn by computing infant mortality-rates based on the nature of the birth attendant, whether a physician or midwife. Comment should be made on the supervision and control of midwifery. Confinement charges of midwives and physicians may be interesting in indicating a tendency to patronize the group with the lower rates for confinement.

Tables may also be constructed showing the relative mortality among breast- and bottle-fed infants. Tables of this character have been published by Dr. L. I. Dublin in an article entitled "Study of Infant Mortality among Infants of Fall River" and an article by Dr. W. H. Davis on "Mortality of Breast- and Bottle-Fed Infants."

The effect of hard labor on the pregnant mother before confinement is well known. A study should, therefore, be made of the entrance of women into the industrial life of the community and the effect on infant mortality.

The wages of the father are important. Where the births of a community are largely among the laboring classes, a high infant mortality-rate may be expected when the wages of the father are not sufficient to provide adequate care and nourishment for the young infant.

Measures directed to the lowering of infant mortality-rates may be sought under two main sources—public and private—and will consist of infant welfare organizations, lying-in hospitals, clinics and nursing or medical service. Each of these factors should be carefully studied to determine the influence their program is having on a reduction of the infant mortality-rate.

Water Supply.—The first considerations of a public water supply are safety and adequacy. If it is a surface water as a river, freedom from sewage pollution should be noted and if from an impounded stream or pond, the danger of surface washings from privies should be heeded. Water from underground sources is usually safe except in a limestone region. The question of adequacy depends not only on normal consumption but also on sudden strains on the service as an extensive fire.

Water is purified by storage or by filtration. If stored the length of storage should be noted, especially if the public supply is from two sources where it may be shown that the period of storage is not sufficient in each instance. The method of purification, where filtration is resorted to, should be described in detail. Chemical disinfection should also be noted. The reservoir, filtering and pumping service should be sufficient to provide for more than the average daily consumption.

The distribution system should be studied to determine whether the bulk of the built up area is connected to the public water supply and not dependent on other sources, possibly polluted, for a potable water.

Communities may have private water systems either of an industrial character as water supplied to homes of industrial operatives, or possibly systems maintained in isolated subdivisions by private owners. Bottled waters may be sold to a considerable extent, or wells frequently used. All of these private sources of supply should be carefully investigated for their safety and, in the case of bottle water, the sterility of the container should be questioned.

Milk Supply.—The study of the milk supply may be started with a statement relative to the ordinances controlling the supply and the legal machinery for their enforcement.

The next step is the production of milk at the farm, the methods employed and equipment used, bearing in mind that essentials in the production of clean milk are clean cows and milker's hand, sterilized utensils with small openings and prompt cooling. The health of cows and milkers is also to be considered and the opportunity of contamination through flies and privies.

The problem of transportation should be considered from the standpoint of the distance of dairies from the city, the methods and rapidity of transporation and the temperature of the milk in transit. If considerable quantities of milk are found to sour in transit, a study of the reasons for this economic loss is in order.

The location and surroundings, cleanliness, methods and equipment of city milk plants, together with the rapidity of handling is next to be considered. The perfection of pasturization is important. Every drop of milk should be maintained constantly for one half hour at 145° F. Apparatus should be clean. Cursory washing and steaming is insufficient. Vigorous scrubbing and prolonged heating is necessary. If the cleansed apparatus still retains a film of grease, high bacterial counts may be anticipated.

The number and hours of delivery and temperature on the wagon are points in the distribution of milk. During summer weather or in southern cities, deliveries between midnight and sunrise may afford several hours' incubation at a warm temperature while the milk is standing on the porch. Other sources of distribution are stores and milk depots and these should be visited to determine the source of supply and the methods and equipment for handling.

Market requirements may be considered for the consumption and standards of different grades as raw, pasteurized, graded, and certified milk.

Finally comes a consideration of the control of the milk supply through bacterial tests, chemical tests, and inspection service.

Disposal of Excreta.—A sewage system is needed for two reasons: protection of public health and the convenience of the householder. It must meet two requirements: quick removal and safety of disposal. Sewerage systems of the water carriage type are known as separate and combined, separate when storm water and household wastes are handled through two services and combined when one system takes care of both supplies. The combined type requires larger pipes and steeper grades. Hence, a first consideration is the topography of the land and the requirements to be met. The amount of sewage and any problems arising because of trade wastes are to be considered.

Next, a detailed description of the collection service itself with a consideration of the maintenance of the service such as flushing, cleaning and ventilation of pipes. Determine whether the tie-in between the sewer line and the house connection is under official supervision and control. The reduction of soil saturation and the provision for run off of severe storms may be heeded.

The sewage must be treated and disposed of with safety to the

particular community, or any adjacent. This is especially true where the method of disposal is by the dilution method. A local nuisance must not be created. Successful disposal by the dilution method requires straining and screening to prevent coarse floating particles, swift running streams of fair size, and the absence of coves to receive deposits of sludge. Visit the sewer out-falls and determine if disposal is safe and at all times adequate. Collect and test the effluent for its stability and number of B. coli.

Private sewerage systems as privies or cesspools, or some small system as of a hospital, industrial institution or isolated sectors, must be carefully ascertained and investigated for their safety and maintenance.

Industries and Industrial Hazards.—This section may well be divided into two main parts: a study of the city as an industrial center and a survey of the industries for their industrial hazards, and preventive measures of control.

The study of the city as an industrial center should start with a statement as to whether it is primarily of the industrial type or is more dependent on trade and commerce. The geographical location may determine whether the type is industrial or commercial. The next consideration is the location of the industries of the city whether grouped together in localities within the city or scattered along the city outskirts. The history of the community's industrial progress should be stated and studies made of the value of products, size of establishments and an analysis of the working population by color, sex and industry. The reports of the Census Bureau will prove of service in connection with the studies of value of product, establishments, and working population.

Having a mental picture of the industries of the community, a detailed study should be made of the industries themselves. First is a consideration of the labor ordinances and the machinery for their inforcement, with comment as to their efficiency, adequacy, and completeness. Where industrial accidents are reported fully and the number of exposed employees is known, death-rates for different types of fatal accidents can be calculated, as well as severity and frequency rates for non-fatal accidents. Factories should be inspected for the adequacy of machine safeguarding and the general attitude noted of the plant working force and executives to safety organization. The fire hazard of factories should be studied from three angles; (1) Regulations or methods toward the reduction of the fire hazard; (2) the installation of fire-fighting apparatus and (3) adequate and sufficient exits from the building in case of fire. Health hazards of the factories may be conveniently presented in four main groups: those exposing the workers to poisonous fumes, to industrial dust, to fatigue and to temperature extremes. At the time of inspection, insanitary features of the factory should be noted as well as the occupational hazards. The compensation laws, or the method of compensation, for industrial hazards, among the different factories should be carefully studied and criticized. Preventive medical work should be determined, as entrance

medical examinations, periodical re-examinations, rest rooms and nursing.

Welfare work must be considered as lunch and recreation rooms, vocational training of employees, provision of medical and dental services, commissaries, insurance, service annuities, stock purchase plans and building or remedial loans. Child labor in the factories should be noted and the child labor laws examined for any defective construction. Wages for both skilled and unskilled labor, working hours, regularity of employment, employment bureaus and living costs are other factors for thought.

Housing Conditions.—The first consideration is the growth of the city and the races which have contributed to its increase. Growth may be found slow and regular, or rapid and abrupt. The growth should be studied by different epochs, as agricultural, commercial, and industrial, paying attention to the effect of each epoch on population increases.

A careful study of the traits and habits of the early settlers of the community will prove interesting. Unless marked changes have occurred in the population due to the influx of foreign race stocks or interstate migration, the traits and habits of the present generation will often show a similarity to those of the original settlers.

The next point of interest is the homes of the city, the types constructed by the early comers, and present tendencies. Different race stocks may affect housing conditions for better or for worse. Certain races will not build up property but buy and wring profit from the investment. Other races are builders and take pride in their property. The tendency of some races to group together may lower real estate values in their vicinity. The fine old family mansion of yesterday through successive stages of neglect and decay may become a rooming house for the recently arrived immigrant.

How is the land used? Are homes crowded close together with cluttered up back yards filled with sheds thus increasing the fire risk, or do broad open spaces abound? What influence is exerted by drainage conditions, or land topography, in forcing homes to build close together on the high plateaus? Is the supply of buildings plentiful or are inhabitants practically forced to live in dirty or insanitary dwellings because of a lack of vacant property from which to make a better selection? What is the best method of increasing the supply of homes? Should new areas be developed or a more intensive cultivation be made within the present confines? These are all questions to be considered as a part of the housing situation. The rentals of various classes of property should also be investigated.

The sanitation of the home depends on many factors as the purity of the water supply; is it from a safe public supply or the dangerous shallow dug well? How is sewage disposed of, by a connection to the public system or the open unscreened privy vault? The question of damp, dark, gloomy and poorly ventilated rooms should be given attention for its possible connection to the local tuberculous problem.

Of lesser importance from a health viewpoint is the disposal of garbage and housekeeping tendencies in general.

Finally comes a consideration of the construction and financing of buildings, whether homes are erected as single units at a time by individuals, or developed in groups by subdivision, and whether they are built on a cash-payment basis, or through the loans of a building and loan association.

Sanitation of Schools.—The number of schools, public, private and parochial, and their enrolment should first be considered, following this with a consideration of the school building itself. Possibly two general types will be found, the older buildings of the system and the more modern types. Both types are to be studied as to the number of rooms and floor space per pupil, the protection against fire, as exits, alarms, and fire drills, and finally, the freedom from dampness and lighting facilities of basements especially if they are employed as class rooms. The purity of the water supply is to be questioned and if bubbling fountains are in use notice whether the jet of water is thrown several inches into the air or if the force of flow is so weak that the pupil must practically place the mouth on the nozzle of the apparatus to obtain a drink. Notice whether the disposal of sewage is adequate and safe. The toilet should be clean, free from odor and accessible to the children without exposing them to inclement weather. There should be about five toilet seats for every one hundred boys and seven for the same number of girls.

The floors of classrooms should be constructed of material which is easily kept clean. In this connection, it may be stated that dry cleaning or dusting should be prohibited. Cleaning should be completed at least an hour before the children enter the building. Walls should be of smooth surface, and tinted with some color which does not absorb too much light and is not hard on the eyes. White plastered walls, especially those on which bright sunlight falls, may be productive of eyestrain. Desks and chairs should be of the adjustable type and fitted to the children at the beginning and middle of the school year. Blackboards should be located so as to be easily seen and not placed in dark corners or between windows, the latter arrangement producing a glare hard on pupils' eyes. Windows should be at the left and rear of desks. Window shades should pull up from the bottom as the best and most light comes from the upper part of the window. The glass area of windows should be close to one fourth the area of the classroom floor space. No desk should be more than twenty feet from the source of light and the lower edge of the window should be above the visual level of seated pupils. Rooms should be well heated and ventilated, each teacher being held responsible for the condition of her individual room.

Sanitation of Markets.—Markets of good sanitary construction must be easily cleaned. Floors and inside walls should be of non-absorbent material and of smooth surface which will clean readily. Light and ventilation should be adequate. Hot and cold water should

be provided. Large markets should have fly-proof public comfort stations. Garbage cans should be tightly covered and frequently removed for emptying. Every effort should be made to keep flies out of the market. Doors opened from the outside by pulling and electric fans throwing a current of air toward the door may prove of value. Food must be protected from "fingers, flies and filth" and be sufficiently refrigerated to insure its preservation. The modern way of protecting exposed perishable food is to place it close to refrigerated coils under glass. In this manner, the customer can view the food which is kept cool and protected from dust, investigating fingers, or the inquisitive fly. When studying the sanitation of markets the question of the effect of high food prices on the community health should be considered. If prices are high, the consumer will purchase goods of an inferior quality because the price is cheap. Malnutrition with its attendant evils may thus be produced especially among children. Public markets successfully and efficiently operated may be of help in lowering food costs. To be successful, there should be a demand for them. They should be adjacent to tributary sources of supply, conveniently located, constructed and equipped with due regard for sanitation, and so managed as to operate at cost or but a slight margin of profit.

Street Sanitation.—Describe the equipment of the street cleaning service and follow this with a detailed description of the methods of street cleaning as adapted to the different types of paved streets.

Disposal of Garbage.—State first the early methods of disposal and the reason they were abandoned and follow them with a brief review of the municipal ordinances relative to garbage collection and disposal. The frequency and adequacy of the collection service should be noted and the method of disposal described in detail with criticism of any existing faults.

Medical School Inspection.—School medical inspection service should accomplish two things: protect children from disease and determine their physical fitness. Physical defects should be remedied by the education of parents to the need of correction. Free vaccination should be provided and dental prophylaxis taught.

The accomplishment of these needs requires the services of physicians, dentists and nurses. The medical school inspection service should, therefore, be studied for the program pursued and the personnel and size of the inspection force. In this latter connection, it may be stated that a minimum requirement is one physician for every three thousand pupils and one nurse for every fifteen hundred pupils. The teacher may also render valuable aid to the medical inspection service. She should be trained to recognize symptoms suggestive of communicable disease and exclude each morning from class, pending the arrival of the medical inspector, any pupil whom she considers suspicious.

The directive source of the inspection service should be determined. Most authorities consider that the health officer should be the directive head although it may work out when a part of the school system but coöperating with the health department.

Detailed studies should be made of the cases of communicable disease excluded from school, their isolation, supervision and release. The causes of physical defects in children should be determined, if possible, and preventive measures suggested. The adequacy of follow-up work of the nursing service with parents should be investigated.

Charities.—Charities, public and private, may be a potential force in keeping the community on a healthy basis, because of the aid furnished the indigent sick. The first step is to consider the causes which are producing poverty in the community. Do they pertain to the individual, as alcoholism, drug addiction, venereal disease infection, gambling and idleness? Or may the causes be sought in the individual's environment? Thus we have the industrial environment with its exposure to industrial accidents and occupational diseases. Again, there is the home environment with possible exposure to disease, especially tuberculosis, through ignorance and carelessness. Possibly the child is set at work at an early age and a broken down body is sooner thrown out on the scrap heap of industry. The community may have an unusual number of indigent aged. The records of charitable organizations should afford much light on the causes of poverty as well as the social state of applicants and thus point the way to remedial measures.

What relief is furnished the dependent classes as the homeless, poor and dependent children, the destitute sick, the insane and weak minded? What public relief is given the poor in their homes?

What is being done by the city? Does it provide free medical service in the form of a city physician? Are there free hospitals and dispensaries, free medicine and free nursing service? Does it maintain or contribute to the support of institutions for the indigent aged, the homeless poor, the dependent child or the insane and feebleminded? Are inmates of the various institutions afforded adequate care and attention?

What are the private charitable organization of the city? How are they supported? Do they operate as single units or are they coördinated into a central power of force? Can applicants for relief appeal to several organizations or is a confidential bureau maintained to check this abuse. These conditions should all be studied and presented.

Board of Health Laboratory.—The number of members, and adequacy of the laboratory force should be stated, for both the bacteriological and chemical divisions, with a brief statement as to their ability. Mention should be made of the laboratory equipment and its adequacy.

Knowing the laboratory force and its equipment the extent to which it is used by the physicians of the community should be determined. Several reasons may cause physicians to disregard the laboratory. The older school men trained before the days of bacteriology may pin their faith on their ability as diagnosticians; while the younger men may have a microscope or laboratory of their own. The Board of Health may

not provide material in which specimens for examination may be collected, or if provided the method of their distribution may not be conveniently accessible to the busy physician. For the same reason it may be difficult for the physician to get the specimen to the Board of Health Laboratory and he prevails on the courtesy of the hospital laboratory while he is making his morning call at the institution. A study should be made of the number of yearly specimens examined by the laboratory and comparison made with the number of cases of disease reported to the Board of Health for the same period. In this manner some information may be secured on the use of the laboratory by physicians. The number of total examinations should be analyzed for the omission of any necessary test or tests or too few tests for a particular condition.

Publicity and Education.—Many health departments are awaking to the value of educating the community in problems of public health and hygiene. Several methods have been utilized to this end as bulletins, cartoons, health almanacs, posters, press notices, lectures, popular talks, motion pictures, health exhibits, and intensive campaigns as a "Tuberculosis Day" or a "Baby Week." Forceful copy, in everyday language, used persistently in the daily papers is a strong medium, yet not extensively used. Any of the methods which have been employed from time to time in the community should be carefully studied to see if the method "got across" and was successful in attaining its object.

Mosquitoes Prevention and Control.—The breeding places of mosquitoes should be carefully ascertained such as swamps, puddles, ditches, margins of ponds or other bodies of water, cesspools, cisterns, barrels, pails, street gutters, sewer catch basins, roof gutters, or in fact any receptacle where water may stand for ten days or more with warm atmospheric conditions. Ordinances relative to mosquito control should be given and existing methods of control as screening, draining, frequent oiling and premise inspections carefully studied.

Fly Breeding.—Flies breed in decaying organic matters as stable manure or garbage. As most fly breeding is considered to occur in stable manure the first consideration is the number and construction of stables in the community. Particular attention should be paid to the stable floor, if of dirt, fly breeding is favored in the polluted soil. Receptacles for storing manure should be tight and dark. The stored manure should be collected preferably by the municipal authorities at weekly intervals. The method of disposal should be stated with observations as to its adequacy. Garbage cans should be water tight, covered and frequently collected for disposal. Ordinances relative to fly control should be given and mention made of any "fly campaign."

Rat Eradication.—Rats are found in the wharfs along river fronts, in sewers, stables and markets, warehouses, garbage dumps, slaughter houses or any other place where food may be found. The principal methods of rat suppression may be considered as keeping them away from food, and the rat-proofing of buildings and wharfs. Ships tied

up at a dock, particularly ships from a foreign plague-infected port, should place metal guards on their hawsers. Buildings to be ratproof should have concrete footings, stout metal screens in basement windows, self-closing doors and water or drain-pipes protected by surrounding them with cement. Warehouse doors, or other establishments where food is found, should have a metal reënforcement on the lower part of the door. Rat suppression methods will show some influence on other public health problems as cleaner dairy barns of better construction, prevention of fly breeding in stable floors, and cleaner better-kept back yards and areaways in the tenement house district.

Health Department.—First consider the Board of Health itself. What is its size and composition? Standards will vary in different localities but a small board say of five members is neither too bulky or too small. Its composition in regard to the occupations of its members should be stated. As the Board acts in a judicial capacity for the community public health it should contain representatives from various professions which are associated with public health or its enforcement, as a physician, a sanitary engineer, a bacteriologist and a lawyer. The fifth member might be a representative business man. State the length of service of board members and by whom they are appointed. Inquiry should be made if the Board has full executive powers or is curtailed in some way. The ordinances under which the Board operates should be sufficient to inspect premises, collect specimens, examine individuals and quarantine or restrict their movements when necessary. The manner in which the ordinances are enforced should be stated as by order, abatement, or legal suit. The duties and powers of the health officer and his staff should be considered. The health department staff, may be divided into its component parts as food inspection, medical service and promotion of sanitation. Each department may then be studied for the number or members in its force, their duties and work accomplished during a current year. The health department office, or department of administration should be studied for the manner in which it keeps and files records. A very important division is the section on vital statistics. It should be well equipped, competently managed, and accurately depict the community death-rates. Compilation of records should be along standard lines as exemplified by International Causes of Death, and the rules of statistical practice adopted by the American Public Health Association. Classification of jointly reported death causes should be in accordance with the Federal Census Bureau's "Index of Joint Causes." Intercity comparisons of death-rates are difficult unless such standard and accepted methods are employed by the respective communities.

The Health Department Budget.—The appropriation may be compared with similar appropriations for other municipal departments directed to the conservation or protection of life as the fire and police departments. The total appropriations should also be divided by the total population to bring it to a per capita basis. Various per capita figures have been suggested for health, ranging from fifty cents to one

dollar. The amount of money appropriated for the operation of the health department should be carefully studied for its adequacy. The criticism should be based on whether all the vital health problems are provided for in the budget or if important factors are omitted. For example a health budget could not be considered complete which made no provision for a campaign directed to the reduction of infant mortality or tuberculosis. On the other hand the budget might place undue emphasis on a relatively unimportant health problem as plumbing inspection, or even on an item which might better be taken care of in some other city department as the collection of garbage. Statements have been made by several authorities on the relative importance of various public health problems and suggestions offered as to the amount of money required in the budget for each problem. Possibly no such definite standard can be set. If a community has a high foreign population high death-rates from certain diseases might be anticipated. Again, where there is a high negro population high death-rates for tuberculosis may be expected, or an industrial community with a large number of women at hard labor in its shops might have a high infant mortality-rate. The budget should be sufficiently elastic to meet the particular needs of the community.

CHAPTER VII.

AIR AND HEALTH—VENTILATION.

By C. E. A. WINSLOW, Dr., P.H.

THE RELATION OF ATMOSPHERIC CONDITIONS TO HEALTH AND EFFICIENCY.

Bad Air and Good Air.—The evil effects of bad air conditions are obvious and clearly recognized. In a crowded, ill-ventilated room we experience a feeling of dulness, sleepiness, and under more extreme conditions perhaps nausea, and even faintness; and there are several classic instances in which conditions of the atmosphere have become so extreme as to result fatally. The most famous of these examples is the Black Hole of Calcutta, which Prof. Lee, of Columbia University, has described in the following sentences:

"On one of the hottest of the hot nights of British India, a little more than one hundred and fifty years ago, Siraj-Uddaula, a youthful merciless ruler of Bengal, caused to be confined within a small cell in Fort William 146 Englishmen whom he had that day captured in a siege of the city of Calcutta. The room was large enough to house comfortably but two persons. Its heavy door was bolted; its walls were pierced by two windows barred with iron, through which little air could enter. The night slowly passed away, and with the advent of the morning death had come to all but a score of the luckless company. A survivor has left an account of horrible happenings within the dungeon, of terrible strugglings of a steaming mass of sentient human bodies for the insufficient air. Within a few minutes after entrance every man was bathed in a wet perspiration and was searching for ways of escape from the stifling heat. Clothing was soon stripped off. Breathing became difficult. There were vain onslaughts on the windows; there were vain efforts to force the door. Thirst grew intolerable and there were ravings for the water which the guards passed in between the bars, not from feelings of mercy, but only to witness in ghoulish glee the added struggles for impossible relief. Ungovernable confusion and turmoil and riot soon reigned. Men became delirious. If any found sufficient room to fall to the floor, it was only to fall to their death, for they were trampled upon, crushed, and buried beneath the fiercely desperate wave of frenzied humanity above. The strongest sought death, some by praying for the hastening of the end; some by heaping insults upon the guards to try to induce them to shoot. But all efforts for relief were in vain, until at last bodily and mental agony was followed by stupor. This tragedy of the Black Hole of Calcutta will ever remain as the most drastic demonstration in human history of the bondage of man to the air that surrounds him."

Another famous example of the same phenomenon is described by Lewes. On Friday, December 2, 1848, the steamer "Londonderry" left Sligo for Liverpool with two hundred passengers on board, mostly emigrants. "Stormy weather came on, and the captain ordered every one to go below. The cabin for the steerage passengers was only 18 feet long, 11 feet wide, and 7 feet high. Into this small place the passengers were crowded; they would only have suffered inconvenience, if the hatches had been left open; but the captain ordered these to be closed, and—for some reason not explained—he ordered a tarpaulin to be thrown over the entrance to the cabin, and fastened down. The wretched passengers were now condemned to breathe over and over again the same air. This soon became intolerable. Then occurred a horrible scene of frenzy and violence, amid the groans of the expiring and the curses of the more robust: this was stopped only by one of the men contriving to force his way on deck, and to alarm the mate, who was called to a fearful spectacle: seventy-two were already dead, and many were dying; their bodies were convulsed, the blood starting from their eyes, nostrils, and ears."

The beneficial effects of good air are equally susceptible of demonstration. Dr. Edward Trudeau went to Saranac in 1873 as a hopeless victim of consumption. All his friends were filled with horror at the idea of his going practically alone to die, as they believed, in the Adirondack wilderness, in a little town consisting of little more than a sawmill and half a dozen cabins, forty-two miles from a railroad. Dr. Trudeau did not die, however, during the winter of 1873, but grew very much better; and some ten years later, as a result of his experience, he founded the Adirondack Cottage Sanatorium, which in its primitive form consisted of a single house in which, with great difficulty, he persuaded two consumptive patients to live. That was the beginning of the demonstration in this country of the fresh-air treatment of tuberculosis, which Brehmer and others had introduced on the other side of the water. Today we are going through a reaction against the more extreme applications of very cold air, to sick people and to infants; but the general value of fresh air, if not too cold, and except in certain diseases, has been amply demonstrated.

What are the factors to which these evil effects of bad air and these beneficial effects of good air are due?

Composition of the Atmosphere.—The outdoor atmosphere in a state of normal purity is made up of the following gases, the volumes being measured at 0° C. and at 760 mm. pressure.

COMPOSITION OF THE ATMOSPHERE.

Gases.	Volumes, per cent.
Nitrogen	78.09
Oxygen	20.94[1]
Argon	0.94
Carbon dioxide	0.03
Helium, krypton, neon, xenon, hydrogen, hydrogen peroxide, ammonia, nitric and nitrous acids	traces

[1] 0.01 may be in the form of ozone.

In crowded cities the proportion of oxygen in outdoor air may fall as low as 20.70 per cent. or even slightly less; and the proportion of carbon dioxide may rise to 0.04 per cent. or more.

In addition to these constituents the air always contains a certain amount of water vapor. Unlike the other gases present water vapor condenses at comparatively low temperatures and the amount of water which a given volume of air can hold is directly dependent on the temperature of the air.

AMOUNT OF WATER VAPOR THAT CAN BE RETAINED IN GASEOUS FORM BY AIR AT DIFFERENT TEMPERATURES.

Temperature.		Water vapor.	
°C	°F	Grams per cubic meter.	Grams per cubic foot.
−20	−4	0.887	0.39
−10	14	2.139	0.94[1]
0	32	4.800	2.11
10	50	9.280	4.08
20	68	17.017	7.48
30	86	29.871	13.13

If, at a given temperature, the amount of water vapor in the air is increased beyond the saturation point the excess of moisture condenses out in the form of dew. Or if, with a given amount of moisture in the air, the temperature is lowered a point, called the dew-point, will ultimately be reached at which a similar condensation will take place. The amount of water vapor in the air at a given moment is generally expressed in relation to the total amount which it could hold if saturated. When the *relative humidity* of the air is said to be 75 per cent. we mean that that air contains three-quarters of the amount of water vapor that would saturate it at the existing temperature and pressure. The relative humidity of the air is perhaps its most variable quality at different places and different seasons. According to Macfie[1] the relative humidity in the heart of the Libyan desert may be as low as 9 per cent. of saturation, while at Davos the mean relative humidity is 79 per cent. In California he states that the relative humidity may drop from 100 per cent. at dawn to 22 per cent. at noon.

In addition to its gaseous constituents the air always contains a certain amount of finely divided solid matter in the form of dust particles. If all particles, down to the very finest, are counted as may be done by the optical methods devised by Aitken the numbers found are enormous. They range from less than one per cubic centimeter on mountain tops (on exceptionally clear days) to hundreds of thousands or millions per cubic centimeter in ordinary indoor air. Considering only the particles of sensible weight and size (including diameters down to 0.0001 sq. mm.), recent analyses have shown the presence of .11 grams per million liters of air, or 900 dust particles per liter, in country air on a clear day. At the other extreme 760. grams per

[1] Air and Health, 1910, second edition.

million liters, or 24,000,000 dust particles per liter, have been found in an abrasive factory.

Bacteria are also present in ordinary air, but in small numbers, commonly varying from none to about ten per liter and rising to tens of thousands in very dusty air.

Changes in the Composition of the Air as a Result of Human Occupancy.—Five different changes take place in this normal atmosphere when human beings occupy a confined space.

1. The oxygen is reduced by respiration. Tigerstedt estimates the amount of oxygen absorbed by a man of average weight at rest as 764 grams, or 534 liters per twenty-four hours.

2. The carbon dioxide is increased by the same process. The oxygen consumption cited above, with a respiratory quotient of 0.80, would yield 840 grams, or 427 liters of CO_2 per twenty-four hours.

3. There is given off into the air a greater or less amount of organic matter, which is perceived by us as odors—material given off not from the lungs to any extent but from the mouth, from the teeth, skin, and clothing.

4. The temperature of the air is raised by the heat given off in the process of metabolism. The number of calories produced in twenty-four hours, corresponding to the oxygen consumption of 534 liters cited above, would be 2563.2 calories. About four-fifths of this, say 2000 calories, is given off from the skin. Lusk and his associates have recently shown that the heat production bears a direct and close relation to the superficial area of the body and amounts for a resting individual to 953 calories in twenty-four hours per square meter of body surface (corresponding to an oxygen consumption of 198 liters per square meter of body surface).

5. The humidity of the air is increased by the moisture given off in the breath and from the skin. The amount of moisture evaporated has been estimated as in the neighborhood of 1400 grams in twenty-four hours for a man at rest. All of these values may be greatly increased by active exertion, and the amount of water given off, in particular, is radically altered by the heat and humidity of the surrounding atmosphere.

Coincident changes in bacterial content and dust content (the latter influenced mainly by industrial processes) will be discussed in later sections.

Physiological Effects of Changes in Oxygen and Carbon Dioxide.—In seeking, among the various changes noted above, for the cause of the physiological effects of vitiated air it was perhaps natural that the mind should turn to lack of oxygen as of prime importance. When a mouse is confined under a bell jar, it dies from oxygen starvation, and it was at first assumed that the same thing happens to a less degree in a badly ventilated room. As a matter of fact men do sometimes die from lack of oxygen in clogged sewer manholes (although poisoning by carbon monoxide is often at fault in such cases) or in the low parts of mines.

In such rooms as are ordinarily used for human occupancy, however, the changes in oxygen and carbon dioxide, even with the worst ventilation, are found to be comparatively slight. The oxygen may fall from 21 per cent. to 20 per cent., and the carbon dioxide may rise from 0.03 to ½ per cent.; greater changes than these are not observed even in the most crowded and worst ventilated room on account of the leakage through walls and ceiling and cracks of all sorts. Such values are very far from the values which are found to produce harmful physiological effects. The air in the lungs under normal conditions contains 16 per cent. of oxygen and 5 per cent. of carbon dioxide and the respiratory apparatus easily accommodates itself to considerable variations in the composition of the atmosphere by slight automatic changes in the rate and depth of respiration so as to maintain the composition of the alveolar air unchanged. In mines the oxgyen is often deliberately kept down to 17 per cent. or less in the hope of avoiding the dust explosions that are likely to follow in freely ventilated mines during cold weather.

Some of the most interesting work along this line has been that in regard to the phenomena of mountain sickness. My colleague, Professor Yandell Henderson, with the English physiologists, Douglas and Haldane,[1] made a most important series of studies of this kind on Pike's Peak. On Pike's Peak the partial pressure of oxygen present corresponds to about 13 per cent. at ordinary atmospheric pressure. Under these conditions there are distinct symptoms of mountain sickness, as a result of oxygen deficiency, blueness of lips and face, loss of appetite, nausea and vomiting, intestinal disturbances, headache, fainting, periodic breathing, and great difficulty in getting breath on exertion. But even here, with the equivalent of only 13 per cent. of oxygen, after a few days the symptoms began to lessen, and after a few weeks of acclimatization the extreme conditions disappeared, although periodic breathing was still occasionally observed, and lips became blue on vigorous exertion. The investigators believed that at least three things had happened in this adaptation: In the first place the cells lining the alveoli of the lungs had acquired the power of secreting oxygen one way and carbon dioxide the other more vigorously for the same gaseous pressure than they would under ordinary conditions. In the second place the alkalinity of the blood had changed so as to stimulate the respiratory center with a less amount of carbon dioxide. And finally the hemoglobin had increased so as to supply the tissues more readily with the needed oxygen.

Many people live active and vigorous lives under such conditions as this. In the great city of Potosi, in the Andes, for instance, the partial pressure of oxygen is very close to that at Pike's Peak, and many famous health resorts at an altitude of 5000 feet have a lower partial pressure of oxygen than obtains in the most crowded room.

Nor have the ordinary changes in carbon dioxide content any greater

[1] Douglas, C. G., Haldane, J. S., Henderson, Y., and Schneider, E. C.: Philosophical Transactions of the Royal Society of London, 1913, series B, cciii, 185.

significance. For decades the carbon dioxide content of the air has been used as an index of its vitiation. Even in the standard text-book on Heating and Ventilation by Hoffman and Raber (published in 1910) one could read that "carbon dioxide is constantly being diffused throughout the air of the room, thus rendering it unfit for use. If this carbonic acid gas could be dissociated from the rest of the air and expelled from the room without taking large quantities of otherwise pure air with it, the problem of the heating engineer would be simplified, but this cannot be done."

Yet Pettenkofer as long ago as 1863 showed clearly that carbon dioxide in itself is quite without effect in the highest concentrations which it ever attains in occupied rooms, and during the last fifteen years the researches of Flügge, Haldane, Hill, Benedict and other physiologists have rendered the classic viewpoint wholly untenable. Benedict and Milner[1] observed seventeen different subjects kept for periods varying from two hours to thirteen days in a small chamber with a capacity of one hundred and eighty-nine cubic feet in which the air was changed only slowly while the temperature was kept down from outside. The amount of carbon dioxide was usually over thirty-five parts per 10,000 (or eight to nine times the normal) and during the daytime, when the subject was active, over one hundred parts, and at one time reached two hundred and forty parts; and all the "morbific matter" or other deleterious entities which usually accompany carbon dioxide must have been present in corresponding proportion. Yet there was no discomfort whatever, and no detectable disturbance of normal physiological functioning so long as the chamber was kept cool.

In certain parts of breweries the carbon dioxide content is maintained between ½ and 2 per cent., without serious effects. The result of a concentration of 2 per cent. of carbon dioxide is simply an automatic 50 per cent. increase in depth of breathing such as occurs with moderate exercise. Only when such an excess of carbon dioxide is combined with vigorous exercise is discomfort experienced; and only when the concentration of CO_2 rises to 5 to 7 per cent. does dyspnea become distressing when the subject is at rest. At 10 to 11 per cent. headache, nausea and chilliness may occur. By observations on conditions in various industries, and at various altitudes, and by detailed physiological experiments of many observers, it has been shown quite conclusively that oxygen may fall as low as 17 per cent., and carbon dioxide may rise as high as 1 per cent. without harmful physiological effects. The body's respiratory "factor of safety" is a very high one, amply sufficient to take care of all variations in oxygen and carbon dioxide which are likely to occur.

Effect of Organic Effluvia in the Air.—It is necessary, therefore, to seek for some other cause than changes in carbon dioxide and oxygen in order to account for the sensations experienced in badly ventilated rooms; and as the carbon dioxide hypothesis became untenable, hygien-

[1] Experiments on the Metabolism of Matter and Energy in the Human Body, U. S. Department of Agriculture, 1907, Bull. No. 175.

ists next turned to the possibility that poisonous organic substances might be given off from the human body. The obvious presence of "body odors" due to the decomposition of organic wastes in the mouth and on the skin and in the clothing gave a color of probability to such a hypothesis. This problem of "crowd poison," "anthropotoxin," "morbific matter" was a difficult one to study. It was simple enough actually to test the effect of various percentages of carbon dioxide and oxygen, but with organic matter of a hypothetical nature the opportunity for mystic imaginings was almost unlimited.

The conception of subtle organic poisons in the air is probably due to Brown-Séquard more than to any one else—Brown-Séquard, notable among biologists because he had three or four entirely erroneous opinions on important points which he supported by brilliant and apparently convincing experiments, and which it took decades to disprove.

The putrefactive gases given off from fecal materials might be considered as an extreme limiting case for the study of the effect of organic effluvia upon health. Even here, however, it seems doubtful whether any injurious influence can be shown.

Delepine[1] could not detect any influence of sewer air either upon the growth curve of cats, rabbits and guinea-pigs or upon their susceptibility to a spontaneous epidemic due to infected food. David Greenberg repeated Alessi's experiments in the laboratory of the writer with entirely negative results (except for an initial slackening of growth which will be referred to later on).

In a suggestive series of investigations conducted by Professor M. J. Rosenau, of Harvard, the attempt has been made to use the reaction of anaphylactic shock for the detection of very minute quantities of organic substances in the air. Professor Rosenau believed that he had demonstrated that there were such substances present in the expired air. He collected, for example, the matter expired in the breath of a dog and injected it into a guinea-pig, and later injected dog-blood serum into the guinea-pig, when the guinea-pig died with symptoms of anaphylactic shock, which would indicate that there was a specific protein substance given off in the breath, although of course not necessarily an intrinsically poisonous one. These experiments have now, however, been repeated by three other observers, by Leonard Hill in England and by Weismann and Lucas in New York City, the latter of whom worked under the direction of the writer. All three entirely failed to confirm Rosenau's experiments.[2]

Finally, some experiments carried out by the New York State Com-

[1] Report of the Sewer Ventilation Committee upon the Effects on Health of the Air of the High Street Sewer in Manchester, 1909.

[2] Rosenau, M. J., and Amoss, H. L.: Organic Matter in the Expired Breath, Jour. Med. Research, 1911, xxv, 35. Lucas, D. R.: An Investigation of Respired Air to Detect the Presence of Proteid Matter by the Anaphylactic Reaction, Report of Committee on School Inquiry to the Board of Estimate and Apportionment, New York City, 1913, iii, 670. Weisman, C.: Biochemical Studies of Expired Air in Relation to Ventilation, Dissertation submitted to Faculty of Pure Science of Columbia University, 1913.

mission on Ventilation reopen this question in a somewhat different form. In the course of these experiments subjects kept in an experimental chamber under controlled atmospheric conditions were served with a standard luncheon, and the amount that they left on the plates was afterward weighed so as to see how much they had eaten. We gave our subjects on certain days fresh outside pure air, on other days we kept the same air in the room all day, allowing it to become chemically vitiated but regulating its temperature. We found, somewhat to our surprise, that comparing the fresh-air and vitiated-air days with the same temperature and humidity there was a distinct difference in the amount of food eaten. The four series which were completed showed uniformly an excess of food eaten on fresh-air days, the excesses in the four series amounting to 4.4, 6.8, 8.6, and 13.6 per cent., respectively. There were from 71 to 160 meals served in each series; and the results are distinctly suggestive of a psychological effect or reflex reaction to the body odor which may apparently exert a measurable effect on appetite.[1] David Greenberg and the writer have been conducting experiments at the Yale Medical School which appear to offer confirmatory evidence along this line. In these studies guinea-pigs exposed to the odors of decomposing feces showed a less rapid growth curve than normal animals for the first few days of exposure. The effect was entirely transitory, however, the animals exposed to the putrid gases soon catching up completely with their controls.

Physiological Effects of Temperature and Humidity.—It was Hermann who in 1883 first pointed out that heat and moisture were probably the factors that produced the harmful effects of bad air rather than its chemical composition, but most of the fundamental work on the subject was done in 1905 or thereabouts by Flügge and his pupils. These experiments have been repeated by Hill and Haldane in England, and by Benedict and others in this country, and all of the results have tended to show that Hermann was correct.[2]

In these experiments the subjects when placed in carefully controlled closed chambers experienced the symptoms that one is accustomed to associate with badly ventilated rooms. If they were allowed to breathe outside air through a tube they were not relieved. If subjects outside were allowed to breathe the vitiated air through a tube, they did not experience discomfort. These two simple experiments appear to be entirely conclusive as to subjective symptoms. The feeling of uncomfortableness affected the men in the chamber, not the men outside the chamber, whatever air each group was breath-

[1] Winslow, C.-E. A., and Palmer, G. T.: The Effect upon Appetite of the Chemical Constituents of the Air of Occupied Rooms, Proceedings, Soc. Exper. Biol. and Med., 1915, xii, 141.

[2] Flügge, C.: Ueber Luft Verunreinigung, Wärmestauung, und Lüftung in geschlossenen Räumen, Ztschr. f. Hyg. u. Inf., 1905, xlix, 363. Henderson, Y.: The Unknown Factors in the Ill Effects of Bad Ventilation, Trans. Fifteenth Inter. Cong. on Hyg. and Demog., Washington, 1913, ii, 622. Hill, L., and Flack, M., McIntosh, J., Rowlands, R. A., and Walker, H. B.: The Influence of the Atmosphere on Our Health and Comfort in Confined and Crowded Spaces, Smithsonian Miscellaneous Collections, 1913, No. 23, vol. lx, Smithsonian Institution, Washington.

ing. It was the heat and moisture produced by their bodies which caused the feeling of discomfort, by its effect not on the lungs but on the skin.

Leonard Hill comments on his experiments in England as follows:

"In one class of experiments we shut within the chamber seven or eight students for about half an hour and observed the effect of the confined atmosphere upon them. We kept them therein until the CO_2 reached 3 to 4 per cent., and the oxygen had fallen from 17 to 16 per cent. The wet-bulb temperature rose meanwhile to about 80° to 85° F., and the dry-bulb a degree or two higher. The students went in chatting and laughing, and by and by as the temperature rose they ceased to talk and their faces became flushed and moist. We have watched them trying to light a cigarette (to relieve the monotony of the experiment) and puzzled by their matches going out, borrowing others, only in vain. They had not sensed the percentage of the diminution of oxygen, which fell below 17. Their breathing was slightly deepened by the high percentage of CO_2, but no headache occurred in any of them from the short exposure to from 3 to 4 per cent. CO_2. Their discomfort was relieved to an astonishing extent by putting on the electric fans placed in the roof. While the air was kept stirred the students were not affected by the oppressive atmosphere. They begged for the fans to be put on when they were cut off. The same old stale air containing 3 to 4 per cent. CO_2 and 16 to 17 per cent. O_2 was whirled, but the movement of the air gave complete relief, because the air was 80° to 85° F. (wet bulb), while the air enmeshed in their clothes in contact with their skin was 98° to 99° F. (wet bulb). The whirling away of this stationary air cooled the body effectually, for air at 80° to 85° F. holds considerably more water vapor when heated up to from 98° to 99° F."

Such experiments as these have demonstrated quite conclusively that the cause of the ordinary sensations of discomfort experienced in a badly ventilated room are, as Professor Lee has expressed it, "physical not chemical; cutaneous, not respiratory."

The regulation of body temperature among the higher mammals and birds is accomplished in part by modification of heat production, in some small part by varying heat loss and evaporation from the respiratory mucous membranes, and in the main by varying heat loss and evaporation from the external skin. Changes in heat production are accomplished through increased or decreased muscular activity, and increase in heat loss at high temperatures is facilitated by panting, though this is only important in animals which do not perspire freely. In man heat loss is regulated almost exclusively by changes in the dilation of the bloodvessels of the skin and by the varying activity of the sweat glands—operating under the control of the heat center in the corpus striatum.

In view of the importance of evaporation as a factor in the regulation of heat loss, humidity must always be considered as well as temperature in judging of the effect of any given atmospheric condition upon the

body. Haldane, the English authority upon this branch of physiology, maintains that "it is the temperature indicated by the wet-bulb thermometer (not the actual air temperature as shown by the dry-bulb thermometer, nor the amount of moisture in the air, nor the relative humidity) which determines the ill effects produced." (See page 286.) A third condition, air movement, is an equally important factor in the problem, since in a still atmosphere the body is covered by a layer of hot moist air which exerts upon it a direct influence far more detrimental than that of the surrounding atmosphere in general. The combined cooling effect of all three factors can be measured by Leonard Hill's Katathermometer (see page 288). Studies made with this instrument show that a temperature of 26° C. outdoors with a moderate breeze blowing may be more cooling in its effect and hence more comfortable than a temperature of 22° indoors. This is the reason why an overheated room in winter (the air being still) is so much more uncomfortable than a hotter day outdoors in summer (when the air is generally more or less actively in motion).

Striking evidence in regard to the effect of high temperature combined with high humidity was accumulated in connection with the work of the English Departmental Committee on Humidity and Ventilation in Cotton Weaving Sheds (1909, 1911). Experts testified in this inquiry that the workers in mines subjected to a high wet-bulb temperature exhibit a marked degree of lassitude and exhaustion. According to Professor Cadman exertion begins to be accompanied with depression from a wet-bulb temperature of about 25° C. At 27.8° wet bulb "if clothes be removed and maximum body surface exposed work can be done providing a current of air is available." At 29.4° "only light work is possible," and at 35° work becomes out of the question.

Haldane in the same inquiry says that soldiers marching in uniform are liable to heat stroke at wet-bulb temperatures of under 21° C.; that at 26.7° wet bulb a marked rise of body temperature is noted with muscular exercise, and hard and continuous work is impracticable even when the subject is stripped to the waist; while at 31°–32° wet bulb "in fairly still air the body temperature begins to rise, even in the case of persons stripped to the waist and doing no work; and when once started this rise continues until symptoms of heat stroke arise, unless the person leaves the warm air."

The ultimate effects of overheating when carried to its physiological limit have been well described by Charles N. Fiske,[1] Surgeon in the United States Navy. Temperatures in the furnace rooms of naval vessels in the Tropics in early days sometimes passed 65° C. dry bulb and in one case reached 96° with a high humidity. In 1909 and 1910 the attack rate for heat stroke in the Navy was about 8 per 1000 and between 1861 and 1911 there were twenty deaths and thirty-three men invalided from this cause. Severe cramps and muscle twitchings

[1] Am. Jour. Med. Sc., 1913, cxlv, 565.

attributed to local dehydration of tissues and accumulation of katabolic products in excess are among the pronounced symptoms of heat stroke, and the body temperature regulation may be completely upset so that a fever temperature of 40° to 47° may be recorded. The symptomatology and pathology of this disease strongly suggest an auto-intoxication due to metabolic products and a striking analogy has been suggested with the phenomena of fatigue.

In the practical study of ventilation we are less concerned with such extreme influences of very high temperatures than with the slower and more subtle effects of less excessive temperatures; and in this latter field the extensive investigations of the New York State Commission on Ventilation have thrown some new light upon the general problem.

These experiments dealt with the effect upon a large number of subjects of three atmospheric conditions: 20° C. with 50 per cent. relative humidity (13° wet bulb); 24° C., with 50 per cent. relative humidity (16° wet bulb); and 30° C. with 80 per cent. relative humidity (27° wet bulb). At 24° dry bulb the average rectal body temperature of the subjects was 2 per cent. higher and at 30° it was 5 per cent. higher than at 20°, showing that the homoiothermy of the human body is after all only relative and not absolute, even within a moderate range of atmospheric temperature. A somewhat surprising observation was the close relation between the rectal body temperature at 9 A.M. and the mean air temperature for the twelve hours preceding. The curves were so perfectly parallel as to leave no reasonable doubt of the direct relation of cause and effect. There have been conflicting results reported by various observers who have compared body temperatures in the Tropics and in the Temperate Zone; and it may be that after a prolonged sojourn in a warm climate a compensating mechanism is developed which maintains a lower body temperature with a given atmosphere outside.

In addition to this direct effect upon the body temperature, atmospheric heat exerts a somewhat profound influence upon the general status of the vasomotor machinery. It was shown in the New York experiments that the reclining pulse-rate was on the average 5 beats higher and the standing pulse-rate 12 beats higher at 24°—the reclining pulse-rate 8 beats higher and the standing pulse-rate 17 beats higher at 30°—than at 20°. The systolic blood-pressure was not affected at 24° but was decreased by 2 mm. reclining, and by 7 mm., standing, at 30°. The diastolic blood-pressure, reclining, was 5 mm. lower at 24° and 10 mm. lower at 30°, while the average for the standing position was the same at 20° and 24° but was lowered by 7 mm. at 30°. The Crampton value, an arbitrary index of the general tone of the vasomotor system, obtained from the relation between the changes in blood-pressure and heart-rate on passing from a reclining to a standing posture, was 58 at 20°, 53 at 24°, and 36 at 30°, indicating a progressively less efficient condition of the vasomotor mechanism with increasing atmospheric temperature.

In other words an overheated room—even a moderately overheated

room (24° C. or 75° F.)—produces profound effects upon the circulatory and vasomotor systems of the body, including an increase in body temperature and heart rate and a lowering of the Crampton and other indices which measure the facility of adaptive reaction of the vascular system. No other physiological effects than these could be demonstrated even at the extreme condition of 30° C. (86° F.), with 80 per cent. relative humidity; respiratory rate, dead space in the lungs, acidity of the blood, respiratory quotient, rate of heat production, rate of digestion, protein metabolism, concentration of the urine and skin sensitivity being all studied in the New York experiments. Stagnant air at the same temperature as fresh air, even when it contained

FIG. 23.—View of experimental chamber, New York State Commission on Ventilation. One subject at the left is having blood-pressure reading taken, while the other three are typewriting under the direction of the psychologist.

2 per cent. or more of carbon dioxide and all the organic and other substances present in the air of an unventilated room, had no measurable effect on any of the responses studied, aside from the influence on appetite discussed above.

Effect of Atmospheric Temperature and Humidity upon Efficiency.—The most significant results of the New York State Commission study are probably those which bear on the effect of high atmospheric temperatures upon the working power—or more properly, the actual performance of the working organism. The statement must be limited in this way because the actual *power* to do either mental or physical work, for a short period, and under a strong stimulus, was not diminished, under the conditions of our experiments, even by the extreme

condition of 30° temperature with 80 per cent. relative humidity. The observations of Cadman and Haldane, cited above, make it probable that very heavy or prolonged work would have been really impossible under these atmospheric conditions but we did not reach this limit. Short of the point where marked pathological changes set in, it is a matter of common experience that even a highly uncomfortable degree of heat is no hindrance to absorbing intellectual work and no bar to a good game of tennis.

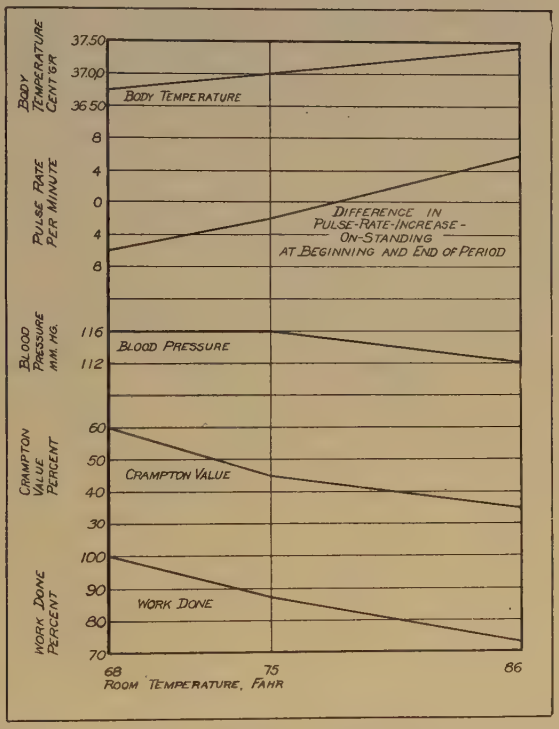

FIG. 24.—Effect of room temperature upon body temperature, pulse-rate, blood-pressure, Crampton value and efficiency. (New York State Commission on Ventilation.)

The effect actually noted in the New York Commission studies was of a somewhat different kind and was brought out by a series of "option tests" in which the subjects were not forced to work at all but, during a given period, were given a choice between physical or mental work on the one hand and idling on the other. If they did perform the work they were paid a small cash bonus, so adjusted as to offer a slight, but only a slight, incentive—a condition approximating the ordinary conditions of school and industrial life (where payment is not on a piece work basis), in furnishing a real but not an overmastering stimulus to effort.

Even this form of option test did not disclose any inhibiting effect of the 24° condition on purely intellectual work such as mental multi-

plication. On the contrary, the average of three series of tests with 47 different subjects, extending over a period of sixteen weeks, showed that 4.9 per cent. *more* mental multiplication was done at 24° than at 20°. It may be that work of this kind offered a certain mental distraction under slightly uncomfortable conditions; or it is possible that the subjects found the 20° condition somewhat too cool for purely sedentary work. At 30° we found a distinctly unfavorable effect even upon mental multiplication.

Typewriting, which involves a certain amount of muscular exertion (and hence an increase of internal heat production) was clearly affected, in all our experiments, by even a slight increase in atmospheric temperature. The average amount of typewriting done under the conditions of the option tests was 6.3 per cent. greater at 20° than at 24°. With heavier physical work, such as lifting dumb-bells or riding a stationary bicycle, the influence of high temperature was still more marked. Tests made on the same optional basis showed that 15 per cent. more work was done at 20° than at 24° and 37 per cent. more at 20° than at 30°.[1]

These experiments indicate that in the daily life of the school and the factory overheating of the air must exert serious effects upon both efficiency and health. Their results are in general in striking accord with the brilliant investigations of Professor Ellsworth Huntington of Yale University, as presented in his book entitled Civilization and Climate. Professor Huntington studied the effect of season upon mental and physical work—physical work of operatives in various industrial communities from Connecticut to Florida, and mental work of students at West Point and Annapolis. He showed that there was a distinct falling off in the amount of work when the mean outdoor temperatures went above 65° to 70° F. He found that there was a still more marked decrease when the temperature fell below 40° to 50° F. There was a period of maximum productivity in both factories and educational institutions in spring and fall, with a minimum period in winter and another minimum in summer. The most favorable mean outdoor temperature for the twenty-four hours was about 60.° Moderate changes, on the other hand, in either direction were stimulating. In Professor Huntington's book he connects these observations in a most interesting and suggestive way with the efficiency of mankind under the various climates of the globe.

It is possible that these inhibiting effects of increased atmospheric temperature upon the tendency to physical work may be due to tissue intoxications of the same kind as those probably concerned in the incipient stages of heat stroke recorded by Cadman and Haldane, differing from them only in degree. They may also, however, be explained as due simply to an abnormal distribution of the blood supply, and particularly to the relative anemia of nerve and muscle tissue

[1] New York State Commission on Ventilation: Some Results of the First Year's Work of the New York State Commission on Ventilation, Am. Jour. Pub. Health, 1915, v, 85.

which may be assumed to accompany marked dilatation of the peripheral vessels. The fact that a strong stimulus to activity can overcome the inertia involved seems to point in this direction. If this hypothesis be correct the disinclination to do active work at a moderately high atmospheric temperature may indeed be interpreted as a protective reaction designed to guard the body from the evil effect which may follow an energetic heat production under conditions which make heat dissipation difficult.

Effect of Atmospheric Temperature upon Resistance to Disease.—Whatever the mechanism of the action may be it is clear that varying atmospheric temperatures exert a profound influence upon the organism as a whole. We might naturally expect that the resistance to microbic infections and other diseases would also be materially affected by unfavorable atmospheric conditions; and experience shows that such is indeed the case.

The most striking direct evidence in regard to the harmful effect of high atmospheric temperatures is that furnished by the effect of season upon infant mortality. It might be supposed that the infant, having more surface to get rid of the heat in comparison with its bulk, would not suffer severely from heat, but this advantage is much more than overbalanced by the greater sensitiveness of its organization. The combined effect of artificial feeding and high atmospheric temperature is what causes the great loss of infant life from summer complaint. A young baby can usually live in cold weather even when fed with poor cow's milk; a baby can live through severe summer weather if it is fed at the breast or on modified pasteurized cow's milk. The combination is the deadly thing.

The effect of atmospheric temperature upon respiratory disease is particularly direct and important. The studies of Hill and Muecke in England and the experiments of the New York State Commission on Ventilation in this country[1] have shown that in going from a hot room to a cold room the membranes of the nose become paler and less moist, while the inferior turbinates contract. With a sharp and sudden change, however, such as occurs when the subject passes from a hot room into a cold room with a strong draft on the face, it frequently happens that while the redness of the membranes decreases, the swelling and paleness do not decrease but often increase, so that the membranes are swollen and bathed with mucous secretion, but without an ample blood supply—an ideal condition for the cultivation of disease bacteria. Apparently this is the phenomenon which lies at the base of "catching cold" by going from a hot room into the cold air.

In the New York studies a number of workers were examined who had lived under abnormal conditions—furnace men, exposed to hot, dry air; laundrymen, exposed to hot, moist air; and truckmen and teamsters, exposed to severe outdoor-air conditions. Abnormal

[1] Hill, L., and Muecke, F. F.: Colds in the Head, Lancet, 1913, clxxxiv, 1291. Miller, J. A., and Cocks, G. H.: The Effect of Changes in Atmospheric Conditions upon the Upper Respiratory Tract, Tr. Am. Climatol. and Clin. Assn., 1915.

reactions were found among these subjects in much greater degree; and these occupational groups showed much more chronic nasal disease than did normal subjects. About 3 per cent. of normal subjects (students) had chronic diseases of the nasal passages, 19 per cent. of the outdoor workers, 35 per cent. of the furnace men, and 46 per cent. of the laundrymen. Both the experimental work and this statistical work on the various occupational groups pointed to the very serious effects of hot air upon the mucous membranes, and particularly the danger of passing from such a condition into chill outdoor air.

Animal experiments have clearly indicated that exposure to sudden chill exerts a definite predisposing influence toward respiratory infections.[1]

Striking evidence of the effect of relatively slight variations in atmospheric conditions upon the incidence of disease is offered by a study of respiratory disease among school children conducted by Dr. S. Josephine Baker[2] of the New York City Department of Health in coöperation with the New York State Commission on Ventilation. This investigation covered two periods of about four months each during the winters of 1916 and 1917, between 2500 and 3000 children being under observation for each period. The 58 classrooms studied in 1916 and the 76 classrooms studied in 1916-1917 were primarily divided into three groups according to the method of ventilation used. The results will be discussed from this standpoint in a later section. A classification of the data according to the temperature maintained in the rooms is most significant from our present standpoint.

RELATION BETWEEN SCHOOLROOM TEMPERATURES AND RESPIRATORY DISEASES.

Year.	Group of rooms.	Average temperature, F.	Percentage of sessions.			Respiratory disease, rate per 1000 pupil session.	
			Below 60°.	60° to 69°.	Above 69°.	Absences due to respiratory disease.	Respiratory diseases among pupils in attendance.
1916	1	59.1	52	46	2	10.4	42.6
	2	66.6	4	78	18	8.2	58.0
	3	69.8	0	40	60	15.8	68.0
1916–17	1	59.6	42	56	2	10.1	69.3
	2	66.6	2	97	1	9.3	39.5
	3	69.1	0	95	4	15.4	103.7

Respiratory diseases among pupils in attendance were least prevalent during the first year in the coldest group of rooms, but absences due

[1] Miller, J. A., and Noble, W. C.: The Effects of Exposure to Cold upon Experimental Infection of the Respiratory Tract, Jour. Exper. Med., 1916, xxiv, 223.

[2] Classroom Ventilation and Respiratory Disease among School Children, Am. Jour. Pub. Health, 1918, viii, 19.

to respiratory disease in this year and both absences and cases of respiratory disease among pupils in attendance during the second year were least in the rooms averaging 66.6° F. In every instance the warmer rooms (although they only averaged between 2° and 3° higher than the middle class) showed a very materially higher respiratory disease rate than either of the other groups. Other factors than mean temperature that may have entered into these results will be discussed below.

The most striking demonstration of the influence of atmospheric conditions upon human vitality is an exhaustive statistical study of the monthly variations in temperature, humidity and death-rates in different parts of the world by Ellsworth Huntington. Professor Huntington shows by an ingenious method of analysis of millions of deaths in widely separated regions that the minimum death-rate occurs with a mean twenty-four-hour temperature of 64° and a mean twenty-four-hour relative humidity of 80 per cent. of saturation, deviations in either direction being followed by an increasing mortality. Moderate variations about this mean are, however, apparently beneficial and populations exposed for long periods to very uniform climates such as that of California show a markedly increased susceptibility to unfavorably high or low temperatures when they do occur.

Physiological Effects of Atmospheric Humidity.—It is well established that high atmospheric humidity combined with high atmospheric temperature is exceedingly deleterious in its effect on the human organism. This is of course an indirect temperature effect, since at high temperatures the body depends mainly on evaporation to maintain its necessary heat loss and the presence of atmospheric moisture interferes with such evaporation. At very low temperatures high humidity is also harmful since under such conditions the body loses heat mainly by conduction and convection and the moisture deposited in the clothing from a damp atmosphere tends to increase conduction. Thus excessive moisture makes hot air feel hotter and cold air feel colder.

Within the ordinary ranges of room temperature the evaporation effect is the one chiefly to be considered, and inside these ranges a higher degree of humidity is preferred the lower the temperature falls. The Comfort Zone worked out by Ellen H. Richards gives a fairly good view of the way in which sensations of satisfaction vary with changing atmospheric humidities and temperatures (see Fig. 25).

Aside from these effects of atmospheric humidity upon the temperature exchanges of the body it has been believed by many hygienists that a reduction of humidity below the normal had a direct and specific harmful influence of another kind. It has been claimed that very dry air was an important predisposing cause of respiratory disease, and that it was conducive to nervousness and general bodily discomfort.

In considering the influence of dryness, as in the case of temperature, we must take the factor of air movement into account. There has been much loose talk about school rooms "drier than the Desert of Sahara;" and it is true that the air of heated school rooms in cold climates

does often show as low a relative humidity as desert air. G. T. Palmer has recently shown, however, that the actual drying effect, as measured by the water evaporated from a porous cup under standard conditions, is much less in the school room than in the desert on account of the relatively slight air movement.

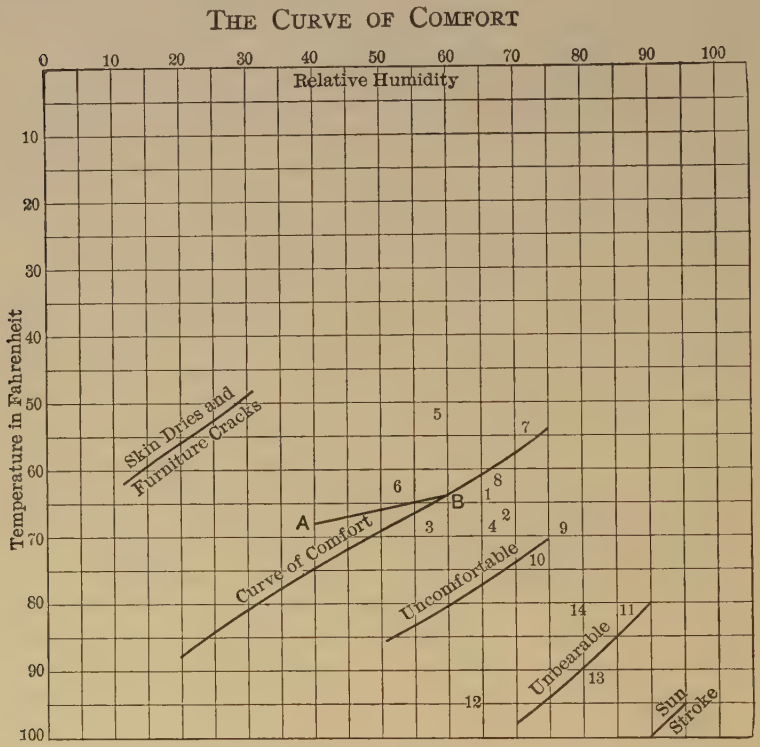

FIG. 25.—Relation between the sensation of comfort and temperature and relative humidity. (Richards.)

Such experimental results as are available in regard to the supposed harmful effect of dry air *per se* are almost wholly negative. The New York State Commission on Ventilation devoted a considerable amount of time to researches along this line. Direct observations of the effect of various atmospheric conditions upon the nose and throat showed that hot moist air was worse than hot dry air, and this conclusion was borne out by the fact that laundrymen, exposed to hot, moist air showed a higher percentage of atrophic rhinitis than furnace men exposed to hot, dry air. In regard to the question of nervousness induced by dry air, the Commission undertook extensive investigation of the psychological reactions of experimental subjects and the health and intellectual progress of school children exposed to air of varying degrees of dryness; but no effect of the dry air could be detected by the methods used. It should be noted that the variations in relative

humidity studied were not very great, ranging only between 20 and 50 per cent. of saturation in the cabinet experiments and between 29 and 42 per cent. in the school rooms, for it is not practicable to humidify school room air to any great extent in cold weather without producing frosting on windows.

The statistical studies of Professor Huntington which have been discussed above indicate, on the other hand, that reduced atmospheric moisture is distinctly harmful as measured by the effect of climatic variations upon the death-rate. The most favorable mean relative humidity for the twenty-four hours as indicated by his graphs is 80 per cent. of saturation, which would perhaps correspond to a midday humidity of 60 to 65 per cent. It may be that the brief period of the New York experiments and the relatively small number of subjects was insufficient to reveal detrimental effects which were really present. On the other hand it is equally possible that the comparatively slight variations in humidity which it is possible to obtain by artificial humidification when operating for the short period of the school session, do not really exercise such influences as are manifested by climatic variations extending over the whole twenty-four hours. The effect of dryness when studied by the statistical method may also perhaps be complicated by other factors such as variability and wind movement.

Bacterial Pollution of the Atmosphere.—In the early days of sanitary science the atmosphere was supposed to play a large part in the spread of disease; but more recent observations have made it clear that the danger of the aërial transmission of bacteria was exaggerated.

Two principal ways have been suggested in which bacteria might be transported through the air—in the form of dust and in the form of mouth-spray. Cornet and many other investigators have dwelt upon the danger of infected dust, particularly in the case of tuberculosis. The dust which collects in streets and on floors and other surfaces indoors is indeed rich in microbic life. Winslow and Kligler[1] report an average of 49,200,000 microbes per gram in New York street dust and between 3 and 5 millions per gram in indoor dust. The flora of the street dust included an average of 51,000 colon bacilli and 42,500 acid-forming streptococci. The results of earlier investigators indicate that the tubercle bacillus may sometimes be found in 5 to 10 per cent. of samples of dust not specially exposed to tuberculous infection, while in the neighborhood of phthisical patients 25 to 50 per cent. of such tests may prove positive. Quantitative determinations suggest that under these conditions *Bacillus tuberculosis* may be present in numbers ranging from 5 to 20 per gram of dust.

It should be emphasized, however, that the dust examined in these investigations was lying inert on floors and other surfaces and could only be distributed in the air by more or less violent agitation. Such distribution does not ordinarily occur. When dust is violently stirred up by dry sweeping or beating carpets indoors or still more by a March

[1] A Quantitative Study of the Bacteria in City Dust with Special Reference to Intestinal and Buccal Forms, Am. Jour. Pub. Health, 1912, ii, 663.

wind in a poorly cared-for street we have, however, another set of conditions. Under such circumstances we take considerable quantities of dust into the nose and throat, and inhaling large quantities of dust may have a real sanitary significance.

The importance of the mouth spray as a disseminator of disease germs was first emphasized by Flügge. It is now well recognized that in coughing, sneezing and loud speaking droplets are thrown out which may contain great numbers of mouth bacteria. Quantitative experiments have shown, however, that the mouth spray is not a floating mist but a fairly coarse rain which quickly settles out of the air and does not produce any important aërial contamination except in the immediate vicinity of the individual producing it. The mouth spray is an important agent in the spread of disease germs, but it is really a form of contact infection rather than a problem of general atmospheric pollution. In the diseases caused by filterable viruses, such as smallpox measles, and infant paralysis, which are characterized by a very high degree of communicability, it is possible that the mouth spray is even more important than in other diseases.

That both dust and mouth spray are local rather than widespread atmospheric pollutions is indicated by the results of bacteriological examinations of air which show numbers so low as to make it clear that a general pollution by either dust or mouth spray must be rare. Baskerville and Browne and the writer[1] have reported, for example, the results of the examination of 1037 samples of air with the average results indicated below. The counts on individual samples varied from 0 to 5200 per cubic foot.

AVERAGE MICROBIC CONTENT OF AIR FROM VARIOUS SOURCES.

Source of samples.	Number of samples.	Microbes per cubic foot. 20°	Microbes per cubic foot. 37°	Acid-forming streptococci per 100 cubic feet.
Outdoors—country	85	56	30	12
Outdoors—city	134	72	32	11
Offices	87	94	80	22
Schools	684	96	..	30
Factories	47	113	63	43

The fact that the acid-forming streptococci which offer a fair index of pollution with mouth-spray are from two to four times as abundant in indoor as in outdoor air is significant of a real, though slight degree of aërial pollution. The relative importance of danger from such diffused pollution must, however, be slight in comparison with the mass infection which occurs in the spread of disease by contact or by exposure to direct and immediate pollution of concentrated mouth-spray.

The principal factor in promoting bacterial infection by means of the mouth-spray is overcrowding rather than poor ventilation, the two conditions being often but not always necessarily correlated. There can be no doubt that jamming of human beings in street cars or

[1] Winslow, C.-E. A., and Brown, W. W.: The Microbic Content of Indoor and Outdoor Air, Monthly Weather Rev., 1914, xlii, 452.

barracks is harmful but the danger can be removed only by relieving congestion. Excessive air movement would aggravate rather than mitigate the evil.

The Harmful Effect of Atmospheric Dust and Fumes.—The breathing of large quantities of mineral or metallic dust produces a definite pathological condition, primarily a fibrosis, known as anthracosis, silicosis, etc., according to the particular kind of dust involved. From the statistics collected by various authorities upon industrial hygiene it appears evident that the inhalation of most types of hard dust produces a marked predisposition to tuberculosis and other respiratory diseases. Among grinders, for example, "grinders' consumption" may account for four-fifths of the deaths from all causes. Coal dust, on the other hand, seems to exert a different effect. While the fibrosis due to the inhalation of most hard dusts predisposes both to pneumonia and tuberculosis, anthracosis predisposes to pneumonia but rather tends to promote immunity against tubercular infection. Ascher has particularly emphasized the liability of those who breathe smoky air to respiratory diseases other than tuberculosis, and in comparing the death-rates in different localities a similar phenomenon has been noted, Pittsburgh and other smoky cities showing a high death-rate from pneumonia and a low death-rate from tuberculosis.[1]

The causation of hay fever and similar diseases by air-borne pollen is an excellent illustration of the possible harmful effects of almost infinitesimally small amounts of atmospheric solids of a specific nature.

In many industries there are special health hazards due to the presence of intrinsically poisonous dusts and fumes such as carbon monoxide, methyl alcohol, sulphur dioxide, benzol and its compounds, lead and arsenic salts and the like. These, as well as the industrial dusts discussed above, are all localized problems of industrial hygiene which will be discussed under that heading in another place. They are to be dealt with less by general ventilating procedures than by the conduct of dusty operations within closed machinery, the special ventilation of grinding and buffing wheels and other dust-generating apparatus and the wearing of respirators by the workmen exposed. The dust in ordinary air, aside from such special factory hazards, has no general hygienic significance.

[1] For data in regard to the influence of dust upon disease see: Cohoe, B. A.: The Relation of Atmospheric Smoke and Health, Bull. No. 9, Smoke Investigation, Mellon Institute of Industrial Research and School of Specific Industries, Pittsburgh, 1914, p. 7. Haythorn, S. R.: Some Histological Evidences of the Disease Importance of Pulmonary Anthracosis, Jour. Med. Research, 1913, xxix (n. s. xxiv), 259. Hoffman, F. L: The Mortality from Consumption in Dusty Trades, Bulletin of the U. S. Bureau of Labor, No. 79, Washington, D. C., November, 1908, 1909, pp. 633–875. Hoffman, F. L.: Mortality from Consumption in Occupations Exposing to Municipal and General Organic Dust, Bulletin of the U. S. Bureau of Labor, No. 182, May, 1909, Washington, D. C., 1909, pp. 471–638. Klotz, O.: Pulmonary Anthracosis—A Community Disease, Am. Jour. Pub. Health, 1914, iv, 887. White, W. C., and Shuey, P.: The Influence of Smoke on Acute and Chronic Lung Infections, Trans. Am. Climatol. Assn., 1913; also Bulletin No. 9, Smoke Investigation, Mellon Institute of Industrial Research and School of Specific Industries, Pittsburgh, 1913, p. 164.

What Constitutes Good Air.—In view of the various influences of atmospheric conditions upon human life which have been discussed above, the essential requirements of good ventilation may be summarized as follows.

1. The air should be cool but not too cold. For ordinary sedentary life in the schoolroom or the office a temperature between 65° and 68° F. should be maintained. In a factory where physical work is performed or in an open-air school where extra clothing is worn the temperature may be lower. Temperatures exceeding 68° (except in the case of aged and ill persons) produce discomfort, injure the vasomotor mechanism, decrease efficiency and predispose to respiratory disease. High temperatures combined with high humidities are particularly harmful.

2. The air should be in gentle, but not excessive motion, and its temperature should fluctuate slightly from moment to moment. A moderate amount of air movement and temperature change keeps the surface of the body cool without chilling it and exerts a pleasantly stimulating effect upon the skin which is lacking either in stagnant air or in a steady warm current.

It will be noted that the problems of ventilation are intimately related to those of clothing and bathing. In each case the chief aim should be to secure a healthy tone of the bloodvessels in the skin. Overheated rooms and too heavy clothing relax and weaken the muscles in the walls of these vessels. Chilly rooms, inadequate clothing and baths that are colder or more prolonged than the body can endure overstrain the heat-producing and heat-regulating machinery and produce the obscure reaction of "chill." Moderately cool, moving air, well-adapted clothing and cold baths within the limits of reaction, stimulate the vasomotor system and make it vigorous and efficient.

3. The air should be free from offensive body odors. As a matter of public decency if not of public health it is desirable that school rooms and auditoria should not offend the noses of those who enter them from outside even though those who have been present while the odors were accumulating are usually unconscious of their presence. If the New York State Commission experiments on appetite are confirmed the presence of such odors may be unhygienic as well as unesthetic.

4. The air should be free from poisonous and offensive fumes and large amounts of dust.

Since the body possesses remarkable powers of adjustment to varying atmospheric conditions custom, and consequent adaptation, play a large part in our subjective symptoms and to some extent in the actual physiological effects produced. The power of acclimatization to mitigate the primary symptoms of mountain sickness has been discussed above. With regard to temperature we undergo marked changes in our responses with the changing seasons. A warm day in May is much more debilitating than a hotter one in July, and a July atmosphere maintained indoors in December is much more harmful than either. So with odors, the olfactory mechanism quickly becomes dulled and

persons accustomed to close rooms endure conditions which would prove unbearable to those not inured to the influences of bad air.

It is evident, however, from such studies as those of Professor Huntington that acclimatization to unfavorable atmospheric conditions is achieved in the long run at the cost of grave stresses of the physiological machine, and that the avoidance of such conditions warrants the most serious attention of the student of hygiene.

PRACTICAL METHODS OF VENTILATION.

Objects and Standards of Ventilation.—Practical provisions for the artificial ventilation of buildings have, in the past, been planned almost wholly with a view to maintaining the carbon dioxide content of the air below a certain level. It was assumed that the carbon dioxide, if not in itself poisonous, was an indirect measure of other chemical impurities and that if this constituent of the air were sufficiently diluted the aims of ventilation would be attained.

On this assumption it is very easy to calculate how much air must be supplied for each occupant of any confined space. One formula commonly used is as follows:

$$Q = \frac{A}{n - p}$$

where Q = cubic feet of air needed per person per hour
A = cubic feet of CO_2 produced per person per hour
n = permissible concentration of CO_2
p = concentration of CO_2 in atmospheric air

The value n is an arbitrary standard fixed by the older hygienists at 6 to 8 parts per 10,000. Applying the lower of these limits

$$Q = \frac{0.6}{0.0006 - 0.0003} = 2000 \text{ cubic feet.}$$

This calculation is the basis of the commonly accepted estimate of 2000 cubic feet of air per hour (roughly 30 cubic feet per minute) as the amount necessary for good ventilation. The value of A is of course less for children than for adults and greater during vigorous exercise than when the persons in question are at rest. By taking account of these variations and above all by different estimates of the permissible CO_2 content (n) standards have been derived varying from 400 cubic feet per hour per capita for schools to 5000 cubic feet per hour per capita for contagious disease hospitals.

From such calculations of per capita air supply a second set of arbitrary constants has been devised to show the necessary allowance of cubic space per person in various occupied places. The air space allowance is calculated as one-third of the hourly air supply on the assumption (scarcely justified with modern ventilation equipment) that the air can be changed only three times an hour without producing objectionable drafts. The following table is an example of such a computation.

ESTIMATED AIR SUPPLY AND MINIMUM CUBIC SPACE ALLOWANCE.

Type of building.	Air supply in cubic feet per capita per hour.	Air space per capita (cubic feet).
Hospitals	2000–3500	700–1200
Factories	1700	600
Prisons	2000–3500	700–1200
Theatres	1400–1700	500–600
Halls and assembly-rooms	1000–2000	400–700
Barracks	1000–1700	400–600
Class-rooms for adults	800–1000	300–400
Schools	500–700	200–250

It should be pointed out that while a certain minimum air space is necessary to make ventilation possible, the existence of ample air space does not on the other hand offer any guarantee that ventilation is taking place. The absence of overcrowding makes it possible to introduce fresh air without creating drafts, but this is of no value if the fresh air is not actually introduced by some efficient means. Thus in a series of factories studied by the British Departmental Committee on Ventilation of Factories and Workshops which were classified according to their capacity in cubic feet per person, the highest mean carbon dioxide values were found in factories with over 5000 cubic feet per capita, the next highest value in those with less than 300 cubic feet. The general average of the 101 rooms with less than 1000 cubic feet per capita of air space was, however, a little higher than the average for 124 rooms with over 1000 cubic feet (10.5 parts per 10,000 against 9.5 parts).

In addition to the pollution from human sources the classic formulæ for ventilation also took into account the carbon dioxide produced by illuminants of various sorts. Bergey in his *Principles of Hygiene* gives the following table in this connection.

VITIATION OF THE AIR BY HUMAN BEINGS AND ILLUMINANTS.

	Development of CO_2 per hour in liters.	Heat in calories.	Water vapor in grams per hour.
Child	10.0	52	20
Youth	17.0	90	40
Man, resting	20.0	130	60
Man, working	36.0	255	130
Candle	15.0	106	10–12
Petroleum lamp	56–61	430–580	35–40
Oil lamp	31–56	200–390	26–40
Gaslight, flat burner	90.0	600–875	130
Gaslight, Argand burner	109.0	800–900	157

In view of our present-day knowledge of the relatively slight importance of the chemical variations in the atmosphere, it seems unnecessary to lay great weight upon the standards based on such computations as those cited above. The student should be familiar with such figures and with their derivation, because they play so large a part in the literature of the subject. We are inclined today to be very lenient,

however, in regard to carbon dioxide standards. The British Departmental Committee on Ventilation of Factories and Workshops (1903–1907) recommended that the CO_2 standard be placed as high as 12 parts per 10,000 during daylight and 20 parts when gas was burning. A standard of 12 parts would require an air supply of only 11 cubic feet per minute.

Considering the problem of ventilation as primarily concerned with heat elimination rather than with carbon dioxide dilution, we can obtain our ventilation standards in another way. According to a low estimate (that of Pettenkofer) an adult gives off 400 British thermal units per hour. Let us assume that this heat must be removed by air entering the room at 60° and leaving it at not above 70°. One British thermal unit raises the temperature of about 50 cubic feet of air by 1°, or the temperature of 5 cubic feet of air from 60° to 70°. Hence, our average adult producing 400 British thermal units will require 2000 cubic feet of air per hour at 60° to keep the surrounding temperature from rising. An ordinary gas burner produces 300 British thermal units per candlepower hour; therefore each such burner requires 1500 cubic feet of air per candlepower. These calculations, of course, ignore direct heat loss through walls and ceiling which, with a zero temperature outside, may carry off the heat produced by 50 or 100 people. In an interior auditorium, however, it is clear that an air supply of at least 30 cubic feet per capita per minute will be urgently required. In many industrial processes in which the heat produced by human beings and illuminants is reënforced by the friction of machinery and the heat from solder pots, furnaces, mangles, pressing irons or other similar sources the amount may have to be increased still further.

The fact is that while 30 cubic feet per minute may be set as a rough standard often desirable to attain, it may be insufficient in certain cases and in many other cases may be an unnecessarily high figure. Hygienists must insist on standards of air conditions actually maintained rather than on any arbitrary mechanical standards assumed to be capable of maintaining them. Any system which does not guard against overheating is inadequate, however large a volume of air may be forced into the room.

In order to avoid malodorous conditions we may fairly demand a certain minimum of air change. In addition, however, we must supply enough air at such a temperature as to prevent the room atmosphere from rising materially above 68°.

Heating and Ventilation.—It is obviously impossible to consider ventilation intelligently without considering heating as well, since the main object of ventilation is to avoid overheating. There are three methods of heating rooms which are in common use: (1) Direct heating is effected by radiators or other heat sources within the room itself; (2) indirect heating is effected by supplying to the room air which has been previously heated elsewhere as by a furnace or a plenum-ventilation plant; (3) direct-indirect heating is a combination

of the other two in which part of the heat of the room is supplied by warm air entering it and part by local radiators.

With direct heating alone some other provision must be made for the air supply necessary to prevent the accumulation of stale odors. With indirect or direct-indirect heating, on the other hand, as commonly practised in schools and other public buildings, it is common to find that the supply of air is more than ample, but that its temperature is so high as to produce a harmful degree of overheating.

FIG. 26.—Types of thermostats for automatic temperature regulation. (Kimball, Lyle and Ohmes.)

Either direct or indirect systems of heating can be controlled by automatic thermostats. These are devices in which the differential expansion of two suitable metals controls radiator valves or dampers in the air ducts. When in good working order such thermostatic systems are highly efficient. In a certain mechanically ventilated school in New York City, for example, where the thermostats were so adjusted as to supply air at 60°, 143 different observations of the room air showed 124 records between 64° and 69°, with 3 below 64° and only

3 above 71°. On the other hand it must be recognized that thermostatic systems very easily get out of order. When the same school cited above was visited a few years later its temperature control was found to be so imperfect that the experiments contemplated had to be transferred to another building. In a New York office building, studied by the writer, 85 offices and workrooms had thermostatic and 147 hand control. There was somewhat greater overheating in the "automatically controlled" rooms than in the others. In one particular room the temperature for a period of twenty-one days in February and March never fell as low as 70° during working hours, and was usually in the neighborhood of 80°. The reason was apparent when it was found that of 213 thermostats in this building, which were individually examined, 110, or 52 per cent., were out of order and not controlling their radiators.

It is obvious that the maintenance of heating systems so that they shall not by their own pernicious activities produce undesirable conditions of excessive temperature is the first task of ventilation.

Natural Ventilation.—In addition to the control of overheating due to the abnormal functioning of artificial heat sources, it is also essential, as pointed out above, to provide in all enclosed spaces sufficient fresh cool air to prevent the accumulation of stale odors and to remove any excess of heat produced by the vital activities of the occupants and by processes of combustion.

This necessary change of air is brought about in all cases, to a greater or less extent, by agencies of natural ventilation. In cold weather, occupied buildings are warmer than the outside air and the difference of temperature produces a chimney action, the warm air escaping from the upper parts of the building and cool air being drawn in below to take its place. Wind pressure accentuates this action and in warm weather this force alone may ensure a considerable circulation of the air.

Even in closed rooms the change of air produced by natural ventilation may be surprisingly large. Märker and Schultze report that from 4 to 8 cubic feet of air per hour may pass through a square yard of sandstone, limestone or brick with a temperature difference between inside and outside air of 9.5° F. The First British Departmental Report on Ventilation of Factories and Workshops (1903) gives some interesting data on this point, obtained by burning candles of known weight (yielding a known amount of carbon dioxide) and estimating the air change by the carbon dioxide content of the room air at the end of specified periods. In a large laboratory room with two double windows and one outside wall of sandstone, one inside wall of brick, one of sandstone and one of wood and plaster, with a temperature difference between inside and outside air of 4° to 9° F., and almost no wind, the room air was completely changed every four or five hours. In rooms with fireplaces the air was changed in one or two hours. With windows open the ventilation may, of course, be increased to almost any degree, depending on variations of temperature and wind pressure.

In dwelling houses where there is no overcrowding natural ventilation of this kind is amply sufficient for all practical purposes. In schools, factories and auditoria on the other hand, where the occupants are crowded together, this procedure is likely to prove inadequate. When the air outside is nearly as warm as that indoors the temperature differences, unless a strong wind is blowing, will provide an altogether insufficient supply of air to remove either body odors or excess heat produced in a crowded room. In cold weather, on the other hand, insuperable difficulties arise as a result of inequalities of distribution. In a school or a factory where there is a row of five or ten or twenty persons extending from a window across to the inner wall of the room it is out of the question to ventilate by admitting the untempered air of winter through that window. Either the temperature near the window will fall so low as to chill those in that vicinity or the temperature at the other side of the room will rise too high, the latter result being the more usual one.

The maintenance of "open-air" schoolrooms at a temperature of 50° F., or thereabouts is a special problem by itself. From a mechanical standpoint there is, of course, no difficulty in leaving windows open, "unhousing," to use a picturesque phrase which has been applied to this process. Open-air treatment appears to be highly desirable for subnormal children, particularly when combined, as it usually is, with provision for special clothing and feeding and short hours and rest periods and special exercises. Without such additional provisions, which are essential for the physically defective but costly and difficult of general application, it is probable that the maintenance of temperatures much below 65° is harmful rather than beneficial.

Natural ventilation, then, works well in the home and works badly in a schoolroom that is designed to be kept at a temperature between 65° and 68°. In the studies of the New York State Commission on Ventilation it was found quite impossible to maintain satisfactory conditions in such schoolrooms by means of window ventilation alone, unless special provision was made for tempering the incoming air and for the egress of stale heated air through special ducts. The cloth window screens which have been advocated by some school authorities for moderating the amount of the incoming air proved particularly unsatisfactory in these experiments.

The hospital ward appears generally to fall in the same category as the living room from the standpoint of the efficacy of simple window ventilation. Patients are, for the most part, in bed or at least warmly clad and under control. Overcrowding is not great, and constant intelligent watchfulness of the extent to which windows are opened is easily possible.

The Fairfield System of Modified Window Ventilation. — An ingenious and simple system of modified window ventilation, devised by Mr. S. H. Wheeler of Bridgeport, Conn., and first installed at the Sherman School, Fairfield, Conn., eliminates the disadvantages of the ordinary natural ventilation while retaining some of its peculiar ad-

vantages. According to this plan fresh air is admitted through the windows, but direct drafts are prevented by placing slanting window boards on the sashes so that the incoming air is deflected upward and mixed with the general air of the room. This incoming current is furthermore tempered by placing the radiators used for direct heating under the windows and by making these radiators large enough to extend over the entire width of all the windows (Fig. 27). Finally, a duct is provided for the egress of warm, vitiated air passing from near the ceiling of each room to the outer air, the upward current in this duct being maintained by the temperature difference between the outdoor and indoor air.

In industrial establishments where crowding is not great the same general principle has been applied by providing special air inlets to individual rooms with heating coils placed directly in front of them.

FIG. 27.—A window-ventilated schoolroom (Fairfield, Conn.). Notice the plates which deflect the air upward and the long radiators under the windows.

An interesting system of ventilation, known as the King system, is in use in cow stables, which secures much better air conditions than those to which human beings are frequently exposed. Louvred openings at the ridge pole furnish an exit for the warm, vitiated air, while fresh air is admitted through ducts in the walls. These ducts open to the outside at the bottom of the wall and to the inside of the stable four or five feet above the floor, the inflowing current of air being induced by the difference in temperature between the stable and the outer air.

With provision for tempering the incoming air, and with gravity exhaust ducts for the outgoing air, modified natural ventilation works very satisfactorily in many schools and in certain factory workrooms. Some schools, however, are so situated with reference to dusty or noisy streets that open windows are out of the question; and in crowded factories, particularly those in which heat is contributed by the indus-

trial processes themselves, some more intensive method of ventilation is essential. In auditoria where crowding is great and the distance to the outer walls considerable, natural or gravity ventilation is almost always inadequate. In such cases we must resort to forced or mechanical ventilation involving the use of fans.

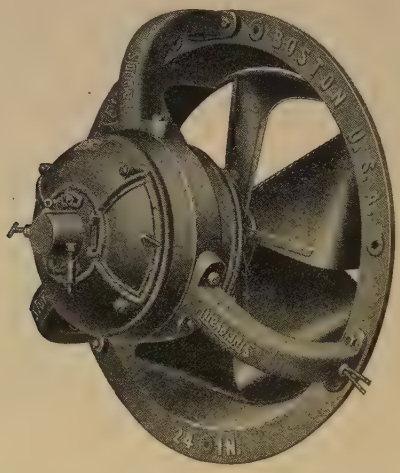

FIG. 28.—Propeller fan. (Kimball, Lyle and Ohmes.)

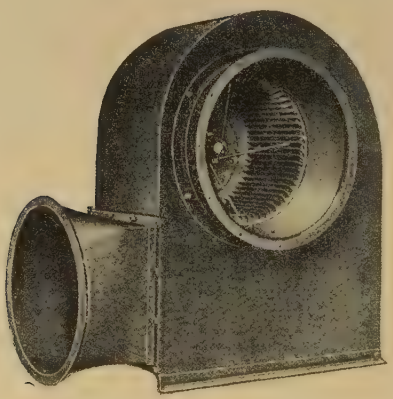

FIG. 29.—Centrifugal fan, ordinary "Sirocco" type; showing suction eye and fan wheel in position.

Forced or Mechanical Ventilation Involving the Use of Fans.—Two general types of fans are used in securing forced ventilation: The propeller type of fan (Fig. 28) works in the open and drives the air at right angles to the general plane in which the fan itself revolves. This form of fan will move considerable volumes of air but only against low pressures, and is well adapted to supplement natural ventilation when only a moderate increase in air change is essential. Propeller fans are often placed in the outer walls of workrooms for example, discharging outward, to accelerate natural agencies in the exhaustion of vitiated

air. Such fans are not, however, suited for use with duct systems of ventilation where the air must be moved against considerable pressure. When the pressure rises their efficiency falls off and a back current is often created, the air flowing in one direction at the periphery and in the opposite direction near the center of the fan.

For systems of duct ventilation the centrifugal type of blower fan is used (Fig 29). The air is drawn in by the central opening at the side and forced out by the revolution of the blades through the duct shown at the left. Fans of this pattern may be used as *pressure* or *plenum fans* when they deliver to the ventilating ducts and draw in their supply freely from an air chamber surrounding them. Or they may be used as *exhaust fans* if the central opening is connected to the ventilating ducts and the delivery is to the outer air. In some buildings with very elaborate plans for ventilation both plenum and exhaust fans and ducts are provided.

It is important in planning for plenum ventilation that the air should be taken in at such a point as to be protected from special sources of odors and dust. The writer recalls the case of an admirably equipped hospital where there was much complaint of stale odors when the mechanical ventilating plant was used. It developed on examination that the fresh air intake on the roof was placed close beside the opening of the soil pipe of the plumbing system and was sucking out the air of the house drain and transferring it to the wards.

Plenum ventilation is often combined with air washing or artificial humidification, and the general arrangement of the inlet end of a fully-equipped plenum system of ventilation and humidification is shown in Fig. 30. The fan draws its air from the fan chamber and forces it out through the duct at the right, the suction which it exerts producing a constant vacuum in the chamber, which draws in fresh air from outside through the screen at the left. In passing from this screen to the fan the incoming air is first heated to a moderate degree (50° to 70° F., depending on various conditions) by passing through the *tempering coils*, which are lines of steam piping like those in an ordinary radiator, but so constructed as to present the largest possible surface to the rapidly moving air. From the tempering coils the warmed air passes through the *spray chamber* or humidifier. This is a chamber filled with a fine mist of water produced by some form of spray discharge, and at its outlet end the air passes between a series of overlapping *eliminator plates* or baffles which change its direction suddenly many times. Contact with these baffle plates removes the excess of moisture which drains off from the eliminator to a collecting pan below.

Three things occur in the spray chamber, when it operates successfully. The air is humidified nearly to the point of saturation. It is cooled by the loss of the amount of heat required to transform the water taken up from the liquid to the gaseous form (5° to 10° in summer time), and it is washed free from a portion of its suspended dust particles.[1]

[1] Much simpler systems of humidification are sometimes installed in which moisture is supplied by evaporation from moist surfaces over which the incoming air is allowed to pass without the production of fine aërial spray.

Finally, on leaving the spray chamber the air passes through a second set of *heating coils*, where its temperature is brought up to the final

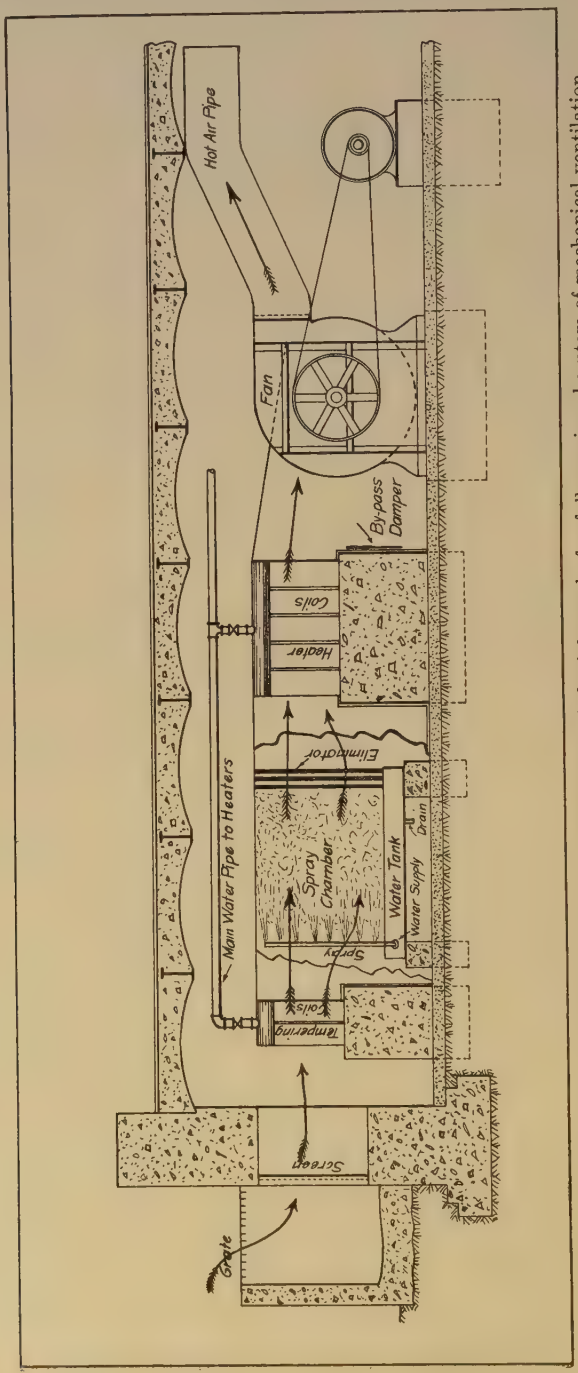

FIG. 30.—Diagrammatic representation of the construction of the inlet end of a fully equipped system of mechanical ventilation.

point desired, ranging from perhaps 60° F., where the removal of the heat produced in an auditorium is necessary to 150°, where a large amount of indirect heating must be accomplished.

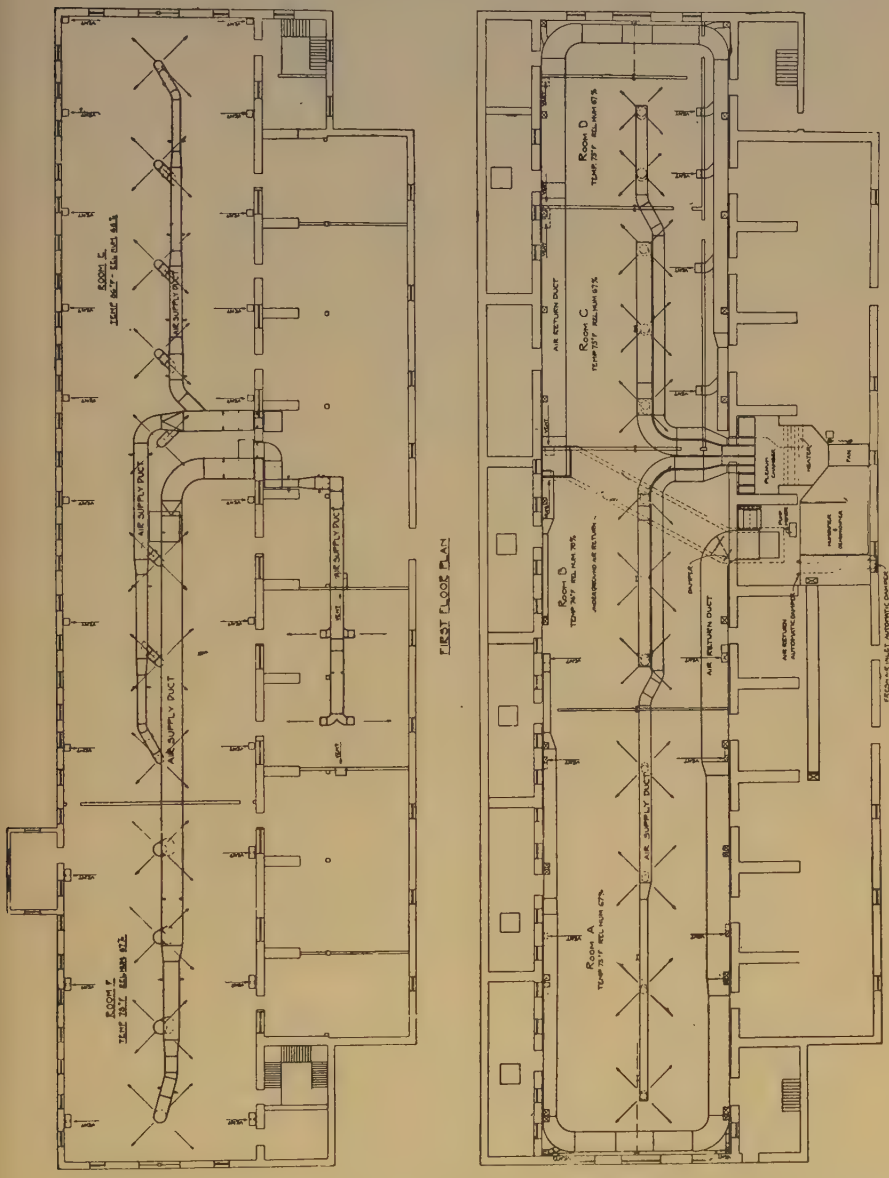

FIG. 31.—Ground and first floor plans of plant of Lubin Mfg. Co., showing layout of ventilating ducts.

The temperature of the air delivered by the fan may be regulated automatically by thermostats controlling either sections of the heating coils or dampers which admit a varying proportion of by-passed air, not passed through the heating coils at all. The humidity of the air

delivered can be regulated by controlling the relative temperatures of the tempering and the final heating coils since the air passing the humidifier is supposed to be saturated at the temperature at which it leaves the spray chamber and its final humidity will obviously depend on the increase in temperature to which it is subjected after this point.

In plenum ventilation without humidification, which is the more usual plan, spray chamber and eliminator plates are omitted, but the fan chamber tempering coils and heating coils remain as shown in Fig. 30. From the fan chamber the air is forced to various parts of the building by a system of ducts such as is shown in Fig. 31. It is impossible here to go into the details of duct construction, but it may be pointed out that many systems of fan ventilation in actual use fail to give satisfactory results because the ducts are so imperfectly proportioned as to distribute the air unevenly between the different parts of the building. Thus in one office building studied by the writer an exhaust system was installed which gave reasonably good results on the six lower floors, while on the upper floors there was either no air flow at all or vitiated air from the lower part of the building was being forced into the room through the supposed exhaust ducts. The problem of the proper proportioning of air ducts is by no means a simple one, as emphasized particularly by the studies presented in the Second Report of the British Departmental Committee on the Ventilation of Factories and Workshops (1907). It is important that individual duct dampers should be provided so that the air supply to each room can be independently controlled; and by somewhat elaborate but wholly practical systems of double or individual duct ventilation even the temperatures of each room can be separately controlled to meet varying conditions of weather and occupancy.

The linear velocity of air maintained in systems of fan ventilation will usually vary from 1200 to 2000 feet per minute in the main duct near the fan. As the air passes through horizontal branch ducts and vertical stacks its velocity is gradually reduced and at room inlets it is usually between 300 and 800 feet per minute. It is desirable that it should not exceed 300 feet per minute at such points in order to avoid unpleasant drafts. In order therefore to provide the air supply of 30 cubic feet per minute commonly believed to be necessary the inlet registers in any room should have a total area equal to 0.1 square foot per capita.

Distribution of Air Within the Room.—In addition to providing a given total amount of air to the room to be ventilated, considered as a unit, it is important to secure a reasonably equable distribution of air within the different parts of the room itself. Local temperature differences and other factors which affect this distribution are complex and variable. It is by no means rare to observe grotesque mistakes in actual practice such, for example, as an exhaust fan of the propeller type placed over an open window producing a strong local up current with no material benefit to the room as a whole. In inspecting a ventilating plant special attention should always be paid to this problem.

The diagrams reproduced in Fig. 32 illustrate the marked variations in air distribution which commonly occur as revealed in studies carried out by the New York State Commission on Ventilation.

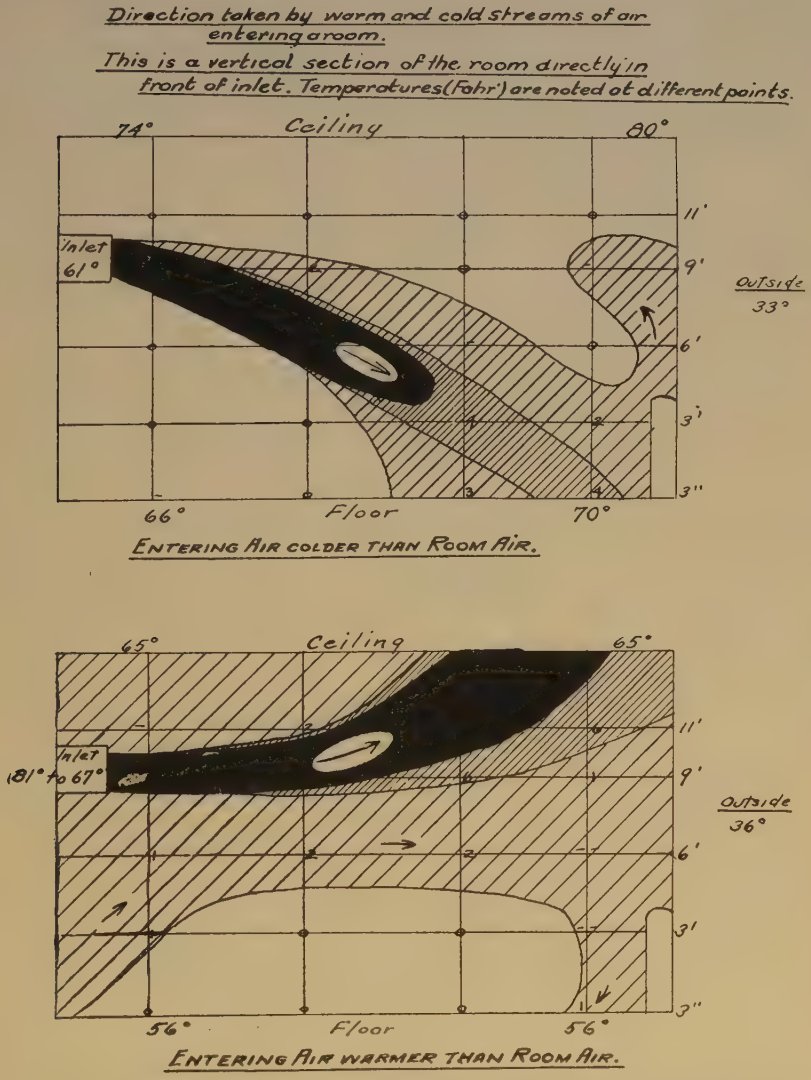

Fig. 32.—Diagram illustrating inequalities in the distribution of air within a room. (New York State Commission on Ventilation.)

There are two general systems of room air supply in common use, the upward and the downward system. The latter plan, which is usually employed in schoolrooms, brings the fresh air in at the top of the inner or warm wall of the room and takes out the vitiated air at the bottom of the same wall. It is assumed in such a system that heating is com-

bined with ventilation and that the incoming air will be warmer than the general room air. If this is the case the warm fresh air will pass across the upper half of the room (see lower chart in Fig. 32) and on striking the outer wall will be cooled and will drop to the floor and recross the room to the exhaust outlets.

If ventilation is frankly recognized as a procedure for supplying fresh, cool air to remove the excess heat produced within a confined space, an upward system of ventilation seems more logical. This plan involves the introduction at or near the floor of air cooler than the general air of the room, this air to become gradually warmed as it rises to exhaust outlets at the ceiling. This is the system commonly employed in ventilating crowded auditoria. In order to avoid unpleasant drafts the admission of air cooler than that of the room must generally be accomplished through multiple inlets which in auditorium ventilation are often placed under each seat; and even with this arrangement complaints of draft are frequent.

With window ventilation on the Fairfield plan the exhaust outlet should of course be placed near the ceiling on the inner side of the room, the general course of the air flow being inward and upward.

Choice of a Method of Ventilation.—It cannot be too strongly emphasized that there is no "system" of ventilation which will ensure universally satisfactory results, any more than there is any "system" of medical treatment which will cure all diseases. Each building, and to some extent each room, furnishes problems of its own which ought to be studied by a competent heating-and-ventilating engineer in order to ensure satisfactory and economical results.

In the hospital ward, as pointed out above, window ventilation alone may suffice. In the schoolroom either modified ventilation on the Fairfield plan or plenum fan ventilation may prove most satisfactory. The New York State Commission on Ventilation has conducted extensive studies on the comparative results attained by these two general methods of ventilation without very striking differences being observed. On the whole the fan system as might be expected changed the air more frequently and showed somewhat lower carbon dioxide values. Probably as a result of the more rapid air change with resulting drafts the temperature of fan-ventilated rooms is generally kept a little higher than that of window-ventilated rooms. There was a somewhat surprising unanimity of opinion among the observers on the staff of the Commission as to the pleasanter quality of the air in the window-ventilated rooms. This may perhaps have been due to the fact that the temperature and movement of the air in the fan rooms were relatively constant, while the air of the window-ventilated rooms was in slight, but variable motion and at any given point showed slight fluctuations of temperature from minute to minute. It is possible that this quality of variability may be an important factor in the agreeableness of the atmospheric conditions which surround the body.

The most striking difference noted between window- and fan-ventilated rooms was the difference in the incidence of respiratory disease cited on p. 254. The figures for this study have been there analyzed

by dividing the rooms into classes according to the temperatures maintained in them. From the standpoint of practical ventilation methods the rooms were of three types: Group A, ventilated by open windows and kept at a temperature between 50° and 60°; Group B, ventilated by windows but kept at about 68°; Group C, ventilated by the plenum system with windows closed and kept at about the same temperature as Group B. It was intended that Groups B and C should differ only in the method of ventilation but as a matter of fact the temperatures averaged slightly higher in the fan-ventilated group. The prevalence

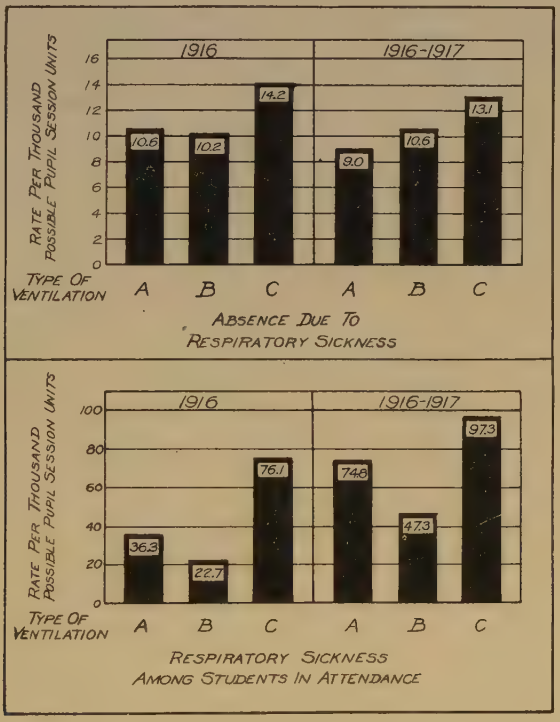

FIG. 33.—Effect of ventilation conditions upon respiratory sickness, plotted from data obtained by Dr. S. Josephine Baker in coöperation with the New York State Commission on Ventilation.

of respiratory disease was materially greater in Group C than in Group B as shown in Fig. 33. The differences which appear when the rooms are thus classified according to ventilation methods, irrespective of temperature, are essentially the same as those which appear when they are classified by temperature irrespective of method of ventilation (see Table on p. 254), the fan rooms including most of the overheated rooms and *vice versa*. It is difficult therefore to say whether the excess of respiratory disease in Group 3 on p. 254 and in Group C in Fig. 33 was due to overheating alone or in part to some other factor, such as temperature variability or type of air movement associated with

plenum ventilation. In any case, however, the study presents the system of window ventilation in a very favorable light.

We should avoid, however, the tendency to accept the Fairfield system of window ventilation as a panacea. It works most satisfactorily under certain conditions; under other conditions, in a school

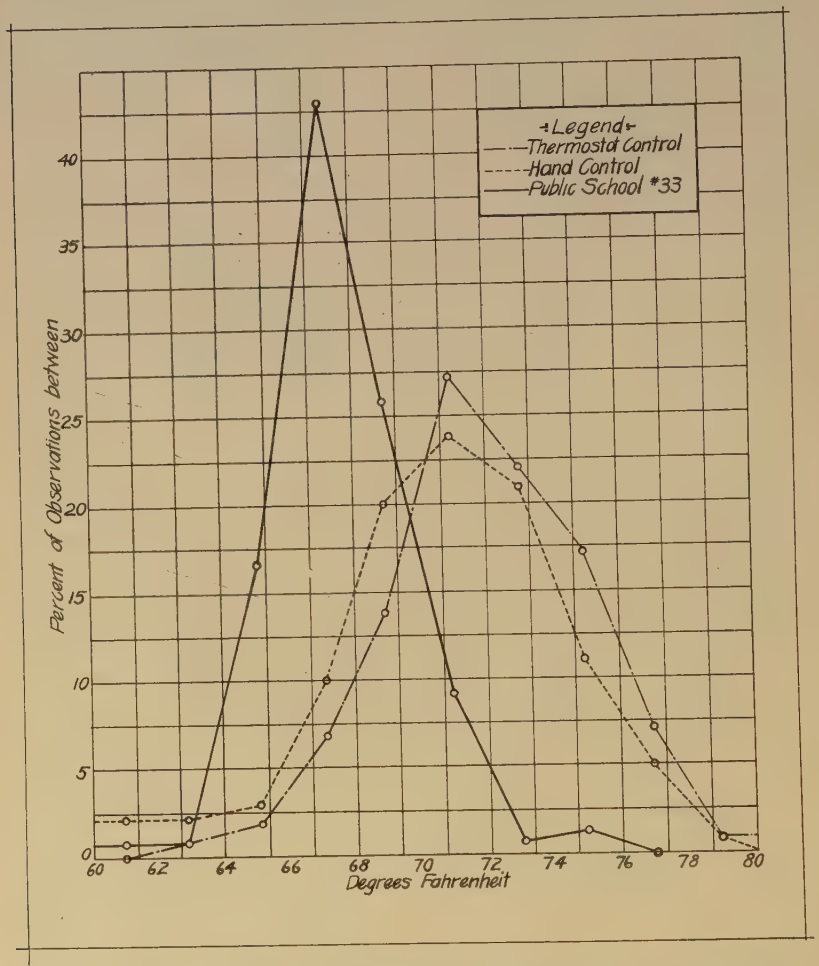

FIG. 34.—Distribution of temperatures in a schoolroom effectively controlled by thermostats, and in two sets of workrooms, one with hand control, the other controlled by a thermostatic system in bad repair.

for example, whose windows can be opened only on a dirty, noisy city street, fan ventilation may be essential. In crowded auditoria and in many factories fan ventilation is certainly the only type of system which will yield the necessary results.

Recirculation.—The recognition that ventilation is not primarily a problem of removing toxic substances but rather one of air conditioning

from the standpoint of temperature and humidity has led to the very interesting suggestion of applying the principle of recirculation to the air of occupied spaces. In applying such a plan the air exhausted from a room is not discharged into the outer air but carried back to the fan room where it is washed by passing it through a humidifier such as has been described above and after its temperature and humidity have been adjusted it is sent back again to the rooms, mixed with a greater or less proportion of fresh outside air. The waste of coal involved in the discharge of exhaust air from ventilating ducts is of course enormous and a system like that of recirculation which promises to save from one-third to one-half of our heating costs has naturally received very serious consideration.

Dr. J. H. McCurdy and Prof. F. H. Bass have reported very satisfactory results from the use of recirculated air, in the Y. M. C. A. College Gymnasium at Springfield, Mass., and in a school at Minneapolis, Minn., respectively.[1] On the other hand, studies conducted by the New York State Commission on Ventilation in a New York City school have been distinctly unfavorable to the process. Even with most careful operation it was found impossible to keep the recirculated air constantly free from body odors by the use of the air washer; and the deodorization of the air with ozone, a process which has been strenuously advocated in recent years, proved even more unsatisfactory. The unpleasant smell of the ozone was added to the body odor without obliterating it. Incidentally it may be remarked that the use of ozone in ventilation is without scientific justification. It cannot disinfect air except in concentrations which are physiologically harmful, and its deodorizing effect is of very uncertain value. Recirculation may be well adapted to certain installations, as at Springfield where it has worked most satisfactorily. To advocate it as a general procedure for school ventilation, under the conditions of operation likely to obtain the country over, would seem to be unwise.

Artificial Cooling.—One application of ventilation principles which deserves far more attention than it generally receives is the possibility of artificial cooling of the air of occupied spaces in warm weather. It is somewhat strange that we freely pour out money to heat, and often to overheat, our buildings in winter while we so seldom think of cooling them in summer. Yet one procedure is quite as practical as the other (though more expensive) and perhaps quite as important from the standpoint of hygiene.

The passage of air through a humidifier, as pointed out above, effects an appreciable degree of cooling; or the incoming air may be cooled by passing it over coils through which cold water or brine is circulated. One of the leading banking houses of New York is provided with a system of ventilation used in this way for heating in winter and for

[1] Bass, F.: The Recirculating of Air in a Schoolroom in Minneapolis, Trans. of the Am. Soc. of Heating and Ventilating Engineers, 1915, xxi, 109–125. McCurdy, J. H.: Gymnasium Ventilation Results, Heating and Ventilating Magazine, 1913, No. 11, x, 26–32.

cooling in summer. A temperature about 10° below that of the outside air is maintained in warm weather, and the writer was told by a member of the firm that there was only one serious objection to the plant—that people who came into the office in summer could never be persuaded to finish their business and go out again. One of the principal hotels in Chicago has an artificially-cooled dining-room that is a constant satisfaction to those who visit it. The Mt. Sinai Hospital in New York has provided a specially cooled room for young children and in view of the direct relation between heat and infant mortality this would seem to be a particularly important application. It seems likely that cooling of the air of occupied spaces in warm weather is likely to be much more extensively developed in the future.

The Factor of Operation.—In all problems of ventilation the factor of faithful and intelligent operation is essential to success. No amount of skilful planning will produce a system that can work itself. Window ventilation requires the constant attention of those in charge of individual rooms. The most elaborate system of plenum ventilation, with automatic temperature regulation, must be constantly watched to see that all its parts are in good working order. Constant vigilance is the price of pleasant and wholesome air conditions.

When a new plant of any kind is installed it should be operated for a time under the supervision of its designer, with careful studies of results, as regards temperature and humidity and air circulation in different rooms and parts of rooms. Such preliminary tests would reveal many minor adjustments likely to improve results materially; and they would make it possible to formulate clear and simple rules of operation which could be turned over to the janitor or other operating agent with reasonable assurance of success.

The Value of Outdoor Air.—Artificial methods of ventilation serve to correct the objectionable conditions of densely occupied rooms and to mitigate the extremes of inclement outdoor weather. No system of indoor air conditioning can, however, equal the outdoor air at its best. Cool open air, fresh and clean and in stimulating motion is the best stimulant for the skin and, with the exercise which accompanies outdoor life, one of the most useful tonics for the whole body.

Windows should therefore be kept open whenever it is possible to do so without harmful drafts irrespective of other systems of ventilation. In the schoolroom it is often found most helpful to throw open the windows for five minutes in the middle of the session while the pupils move about or exercise in order to keep warm. The stimulus of the cold-air bath will more than make up for the lost time; and even in factories such a procedure may prove of practical advantage.

It is particularly important to have plenty of fresh air in the sleeping room. We do not wholly understand why the impact of cold air on the face, with the rest of the body warmly covered, should be beneficial, but experience clearly shows that such is the case. Windows should, therefore, be always open in the sleeping room even in the coldest weather, or the bed placed on a sleeping porch outside.

THE EXAMINATION OF AIR AND THE TESTING OF VENTILATING EQUIPMENT.

Points to be Covered in a Ventilation Survey.—In studying the air conditions in a school or factory or other building, the health officer should first of all obtain a clear idea of the general plan adopted for heating and ventilation, the number of ducts installed for supply and exhaust, and the system, if any, of temperature control. The mechanical constants of the situation should then be determined, including the number of occupants in various rooms and the approximate cubic space per capita. If there is a mechanical ventilating plant its construction and operation should be studied in detail. Velocity of air flow and cubic feet of air supply per capita (based on the population served by each main duct) should be determined when possible by direct measurements in each main duct. The room registers should be measured and their per capita area calculated. As pointed out above, this area should equal about 0.1 square foot per capita. In one case studied by the writer 31 per cent. of the register areas in an office building were inadequate and 54 per cent. unnecessarily large. The air flow at the registers should be measured by means of an anemometer and checked up by measurements of the flow in the main ventilating ducts and studies of the rated capacity and actual performance of the fans. Sometimes the fans will be found to be of a totally inadequate type. Sometimes they can be made effective by simple changes in pulleys or motors which will permit of an increased speed. Sometimes trouble arises from the fact that the engineer is saving coal by operating the fans at reduced speed or not at all. Sometimes the fan is doing its part, while wrong proportioning of register areas and the lack of volume dampers distribute the pressure so faultily that the air is changed too rapidly in one section and too slowly in another. In a large dining hall studied by the writer the exhaust at the end of the room near the fan was 26 to 33 cubic feet per capita, a very satisfactory value, while at the other end of the room it was 7 to 9 cubic feet.

Determinations of carbon dioxide are very helpful as a check on these mechanical measurements, for carbon dioxide is undoubtedly a good measure of the amount of air change which is going on. The table on p. 280, in which the rooms in a large office building have been grouped in four classes according to their provision of duct and window ventilation, shows how well the carbon dioxide values coincide with actual ventilation conditions.

The most important of all steps in a ventilation survey is to obtain an accurate idea of the temperature conditions which are actually being maintained. This can best be done by installing automatic recording thermometers in typical rooms, although such continuous records should always be supplemented by occasional direct records of temperature and humidity made with the sling psychrometer.

The results of such a study can most conveniently be plotted on a distribution curve with temperatures as abscissæ and percentage of

observations in each class as ordinates. The proportion of records above certain temperature limits will give a fair idea of the extent of overheating.

RELATION OF ARTIFICIAL AND NATURAL VENTILATION TO AIR CONDITIONS, NEW YORK OFFICE BUILDING. NUMBER OF ROOMS OF EACH TYPE SHOWING A GIVEN CARBON DIOXIDE CONTENT.

Carbon dioxide parts per 10,000.	4	5	6	7	8	9	10	11	12	13	14	15	16
Rooms with exhaust over 30 cu. ft., window openings over 0.25 sq. ft. p. c.	5	9	8	6	2								
Rooms with exhaust over 30 cu. ft., window openings under 0.25 sq. ft. p. c.	..	1	1	2	1	1							
Rooms with exhaust under 30 cu. ft., window openings over 0.25 sq. ft. p. c.	..	..	12	14	11	2	2	..	1	1			
Rooms with exhaust under 30 cu. ft., window openings under 0.25 sq. ft. p. c.	1	1	3	6	6	4	13	11	5	6	2	..	1

Determinations of aerial dust and bacteria may be desirable in certain special cases.

The methods of making the various observations discussed above are described in detail in the Final Report of the Committee on Standard Methods for the Examination of Air of the Laboratory Section of the American Public Health Association,[1] and in a paper by D. D. Kimball, J. I. Lyle and A. K. Ohmes on the Testing of Atmospheric Conditions and Heating and Ventilating Equipment;[2] and it is upon these two reports that the following brief discussion of the procedures will be based.

Measurement of Air Flow.—The flow of air can be measured in two ways, by direct measurement with the anemometer and by determining the energy of the moving air current by the use of manometers. The Pitot tube is the commonest example of the latter type of instrument;[3] but its use requires considerable technical skill and for ordinary purposes the anemometer may be employed.

A typical anemometer is shown in Fig. 35. The ordinary instrument is reasonably accurate within a range of velocities of from 2 to 20 feet per second, but since the readings obtained are dependent on the friction of moving parts the anemometer must be frequently recalibrated and corrections applied to the recorded velocities. Rough

[1] Am. Jour. of Pub. Health, 1917, No. 1, vol. vii.

[2] Presented at semi-annual meeting of The American Society of Heating and Engineers, Chicago, July 18, 1917; reissued by the society, October 1, 1917.

[3] For a discussion of this instrument see Report of a Committee on Standardization of the Use of the Pitot Tube, Trans. of the Am. Soc. of Heating and Ventilating Engineers, 1914, xx, 210–215.

preliminary observations may be made by moving the anemometer slowly back and forth over the entire area of air flow but in final determinations the instrument should not be moved about, as part of the momentum of the movement is translated into revolution of the vanes. The following procedure should be followed as recommended in a report of the Committee on the Best Way to Take Anemometer Readings:[1]

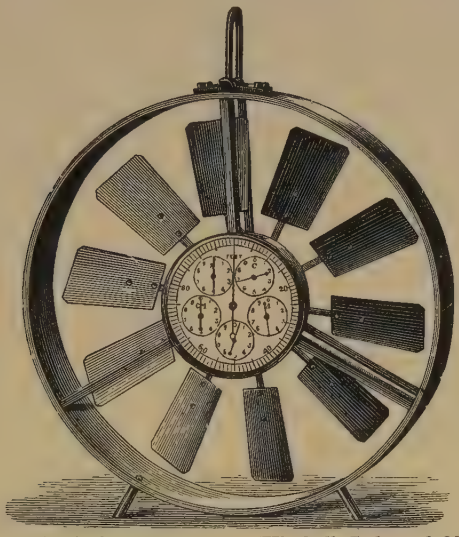

FIG. 35.—Typical anemometer. (Kimball, Lyle and Ohmes.)

1. The opening shall be divided into equal rectangular areas, no side of which shall be over 10 inches long, excepting where this would require more than ten readings, in which case the opening shall be divided into twelve equal areas.

2. Readings are to be taken in every case at the center of every area.

3. Readings are to be of one-half minute duration, the anemometer being held at the register base or in the plane of the opening.

4. Where the diffusers are used, a total area is to be computed on the basis of the periphery of the diffuser.

5. The average of the readings is to be considered as the average velocity at the opening. Where negative velocities are found, they are to be deducted in arriving at the average velocity.

6. In computing volume, the net area of opening is to be taken, the volume to be considered as the product of the average velocity and the net area of the opening.

7. If the anemometer is held two inches from the register face, no deduction shall be made for the area occupied by the register mesh.

Currents of air within the room which are of too slight velocity to

[1] Transactions of the American Society of Heating and Ventilating Engineers, 1913, xix, 202.

be measured by the anemometer may be studied by the use of colored fumes, smoke from joss-sticks, specially delicate anemometers, paper streamers or other methods adapted to local needs.

Determination of Carbon Dioxide.—The Petterson-Palmquist apparatus has been generally accepted as standard for the determination of carbon dioxide in American sanitary investigations. It can now be obtained from Eimer and Amend and many other dealers. In the hands of a skilled operater an analysis can be obtained in five minutes, and for careful work this seems to be the best instrument available. The principle involved is the measurement of a given volume of air, the absorption of the contained carbon dioxide in caustic potash solution, and the remeasurement of the volume of air at the original pressure in a finely graduated capillary tube, the difference in volume representing the absorbed carbon dioxide. The instrument must be carefully adjusted to maintain a uniform temperature and pressure, and the details of manipulation can only be mastered by considerable practice with the instrument in hand.

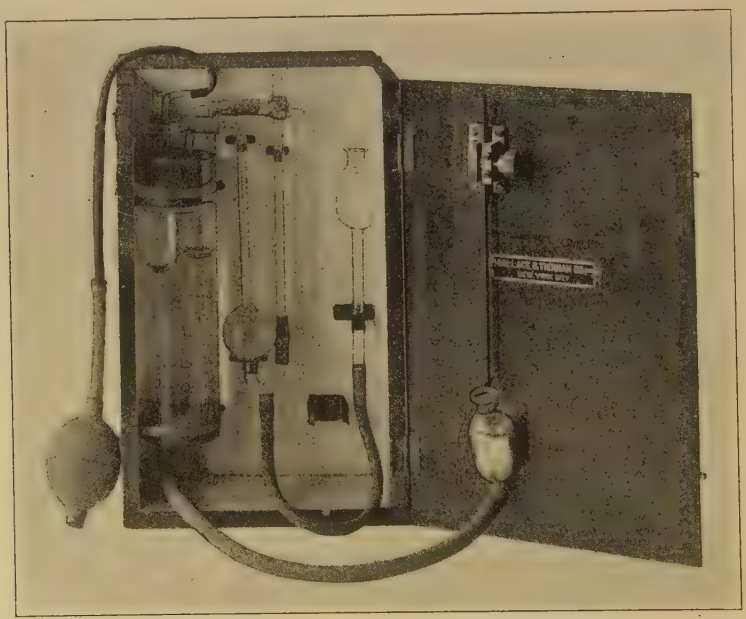

FIG. 36.—Apparatus used for determining the carbon dioxide content of air.

The Petterson-Palmquist apparatus is large and cumbrous for field investigations and in such places as street cars its employment would be out of the question. It may often, therefore, be best to collect the samples in the field and bring them back to the laboratory for examination. The Committee on Standard Methods for the Examination of Air recommends the following procedure:

"Samples are collected in two-ounce, glass-stoppered bottles of clear glass if the analysis is not made with the portable apparatus on the spot.

These bottles hold about 70 c.c., which is enough air to make two analyses, in case it should be necessary—and it is always advisable—to repeat determinations. The stopper of each bottle is greased with petrolatum, or with a mixture of petrolatum and soft paraffin which will spread readily under pressure; and after the sample is taken, the stopper should be turned round and pressed down until no air channels are visible in the petrolatum. The stopper is held in position by a stout elastic band passed over it and a gummed label is placed on the bottle.

"The bottles *must* be dry, and they should be clean. They should be rinsed with clean (preferably distilled) water and completely dried. If a bottle is wet and dirty an appreciable amount of CO_2 may be produced or some may disappear by bacterial action. If, on the other hand, the bottle is wet and clean, carbonic acid gradually disappears, as it is absorbed by alkali dissolved out of the glass by water. In *dry* bottles, even though dusty inside, no sensible alteration takes place within a fortnight or more.

"The sample may be collected as follows: One end of a piece of rubber tubing, two or three feet long and one-eighth or one-quarter of an inch in diameter, is introduced to the bottom of the bottle, the other end being held in the mouth. A deep breath is then sucked through the tube, so that the bottle is completely washed out by the surrounding air. The tube is removed while the air is being still sucked in, so as to avoid any risk of the breath passing backward into the bottle. The stopper is then inserted, turned around, and secured as already described, and particulars written on the label. Care must, of course, be taken that the sample be not contaminated in any way by the presence of persons or lamps."

The chemists of the New York City Department of Health believe that if the sample be analyzed within twenty-four hours no appreciable amount of carbon dioxide will be absorbed by moisture. They recommend the collection of samples in bottles filled with ordinary water corked with a rubber stopper, the sample of air being taken simply by pouring the water out.

Determinations of Temperature.—In view of the fact that overheating has been clearly shown to be the primary cause of discomfort and injury to health in badly ventilated rooms, careful observations of temperature are of the greatest importance in studies of air conditions. With the exception of the determination of rate of heat loss from a warm, moist surface, to be discussed later, temperature records are more significant from a hygienic standpoint than any other class of observations.

Thermometers used for accurate records should be mercury thermometers with engraved stems and no backings. The total graduation range should be from 20° to 120° F., with 1° graduations and no ten degrees should occupy a space of less than one-half inch; so that accurate readings to within one-half degree may be obtained. No part of the body of the operator should be within 10 inches of the bulb when a reading is taken.

In addition to observations made at intervals by the use of the

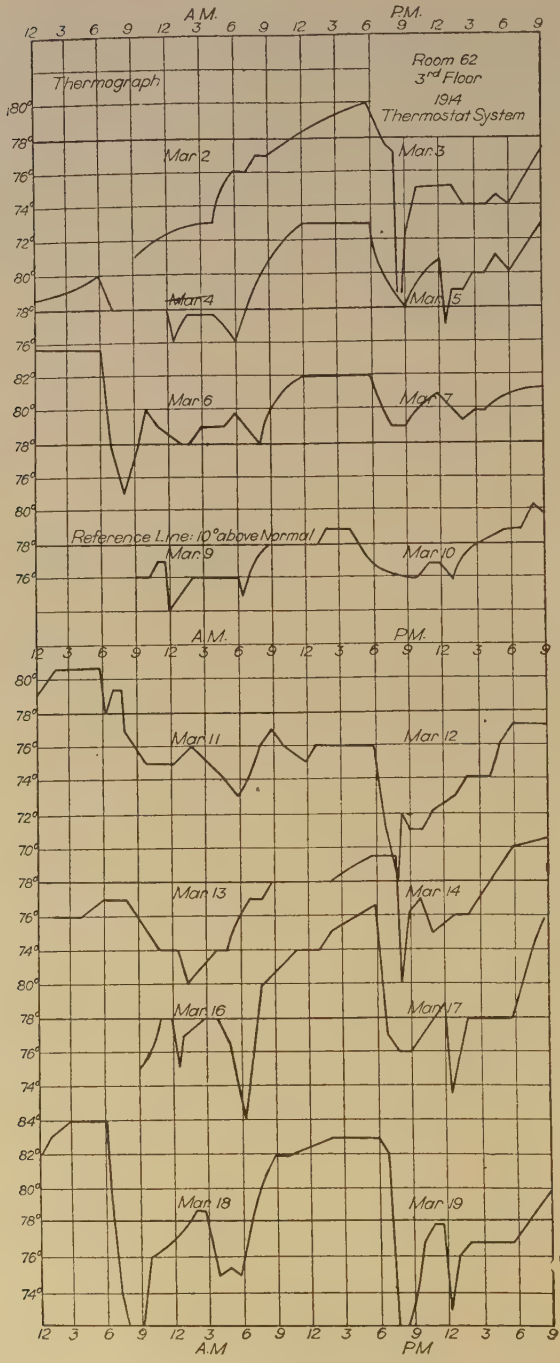

FIG. 37.—Hourly records obtained in an office building where the temperature was badly controlled.

ordinary thermometer continuous temperature records covering periods of several days should be obtained at important points by the installation of recording instruments (see Fig. 37). Recording thermometers are not very accurate and should be checked daily or oftener by comparison with a standard mercury thermometer, but the picture they give of the general variations in temperature during the whole period of occupancy is often highly significant.

The extent of overheating revealed by such studies is sometimes astonishing. Thus in one New York office building 34 per cent. of all observations were between 72° and 75° F., and 9 per cent., 76° and over. In a university dining hall 28 per cent. of all observations were between 71° and 72°, and 16 per cent., 73° and over. On the other hand two window-ventilated hospital wards in New Haven showed less than 5 per cent. of all records over 70°; and a mechanically-ventilated school in New York showed only 3 per cent. over 71°.

Observations made a few years ago by the inspectors of the New York State Department of Labor in a series of 215 factory workrooms (printing shops, clothing shops, bakeries, pearl button factories, cigar factories, laundries and others) gave the results indicated below. All these records were taken when the outside temperature was 70° or below.

TEMPERATURES IN NEW YORK FACTORIES.

Temperature . . .	72° or less	73° to 79°	80° and over
Number of workrooms .	59	93	63

Dr. Helen C. Putnam in a study of 600 schoolrooms reported that only 210 had thermometers, only 140 of the thermometers were in working order, and of these 140 only 20 recorded temperatures below 72°.

In the more advanced communities such conditions as these have become comparatively rare in recent years. A series of over 1800 determinations of temperature in New York City schools gave the following results:

DISTRIBUTION OF TEMPERATURE RECORDS IN NEW YORK CITY SCHOOLS.

Temperature, °F. . .	Under 60	60–61	62–63	64–65	66–67	68–69	70–71	72–73	Over 73
Percentage of total records in each class	1	2	4	11	21	27	20	9	5

Determination of Atmospheric Humidity.—The standard apparatus for measuring humidity (ordinarily used for recording temperature as well) is the U. S. Weather Bureau Sling Psychrometer. This consists of a pair of mercury thermometers mounted on a metal back which is so jointed to a handle that it can be swung in a half circle. One thermometer is of the ordinary type; the other is a wet-bulb thermometer, that is its bulb is enclosed in a muslin bag which is moistened with distilled water just before the instrument is used. The evaporation of moisture from the cloth will of course produce a lowering of temperature and a consequent depression of the reading of the wet bulb

thermometer. The amount of the evaporation and the extent of the depression will vary inversely with the amount of moisture already present in the atmosphere. From a table like that given on p. 287, it is easy from the dry-bulb reading and the difference between the dry and wet-bulb readings to compute the relative humidity of the air and the actual amount of moisture it contains.

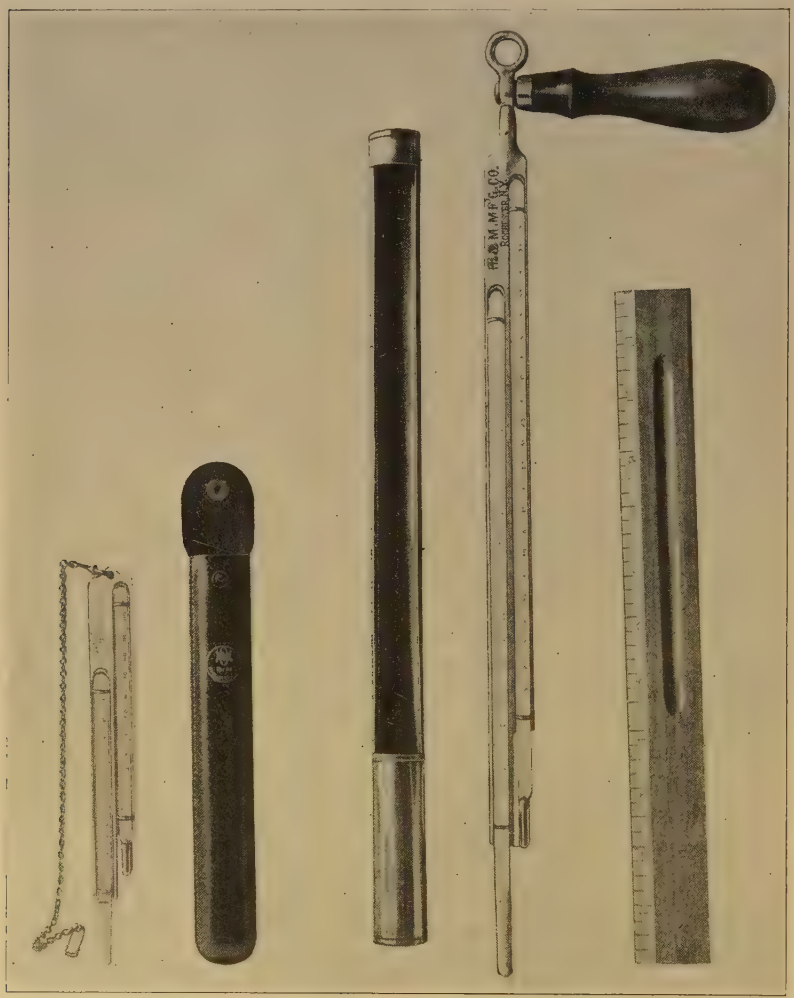

FIG. 38.—Types of sling psychrometers for determining temperature and relative humidity.

The sling psychrometer must be swung slowly back and forth while a reading is being taken so as to prevent the accumulation of an envelope of moist air in the immediate vicinity of the bulb. The process should be continued for several minutes until the wet-bulb reading falls no further. Stationary wet and dry bulb thermometers

(hygrodeiks) are quite unreliable unless air circulation is secured by the use of a fan.

There are upon the market good recording psychrometers in which stationary wet and dry bulbs are played upon by a small fan, the movement of the mercury or inert gas contained in the bulbs being communicated through a tube to a recording apparatus, the record being traced on a paper scale as in the recording thermometer. These are valuable for special studies but the variations in humidity are neither so rapid nor so important as to call for their use in ordinary studies.

In certain factories, and at times in auditoria, humidities may be found which are excessively high. As a rule, however, the humidity

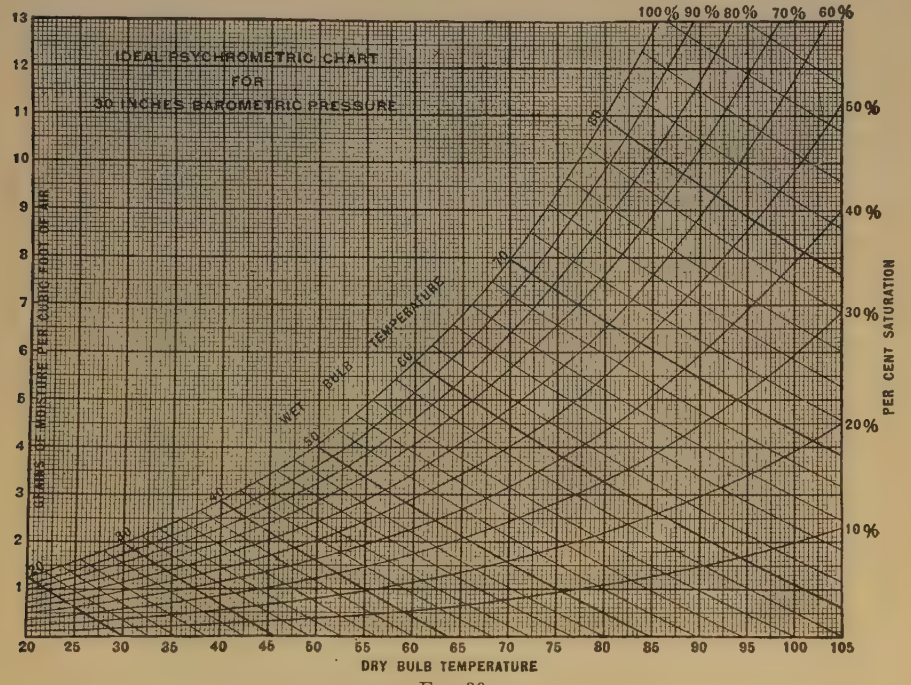
IDEAL PSYCHROMETRIC CHART
FOR
30 INCHES BAROMETRIC PRESSURE
GRAINS OF MOISTURE PER CUBIC FOOT OF AIR
WET BULB TEMPERATURE
DRY BULB TEMPERATURE
PER CENT SATURATION
100% 90% 80% 70% 60%
50%
40%
30%
20%
10%
20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105
1 2 3 4 5 6 7 8 9 10 11 12 13

FIG. 39

of occupied spaces in cold weather at least, is too low rather than too high, since the warming of the cool outside air increases its avidity for moisture, while the actual amount of moisture remains unchanged. The actual results of some 1800 determinations in New York City schools below give a fair idea of conditions in that latitude. Further north, in Montreal for example, the dryness of indoor air in winter becomes even more acute.

DISTRIBUTION OF HUMIDITIES IN NEW YORK CITY SCHOOLROOMS.

Relative humidity percentage of saturation	Under 15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	Over 60
Percentage of total records in each class	6	9	14	17	16	13	10	5	4	3	3

The Kata Thermometer.—The actual temperature of the air, as has been pointed out, is only one factor in determining the effect of atmospheric conditions upon the temperature of the body. Heat loss from the body surface depends upon air humidity and particularly upon air movement, as well as upon air temperature. The ordinary mercury thermometer is, therefore, a very inadequate measure of the actual physiological effect of atmospheric conditions. The condition in a close room has been commonly compared with that which obtains outdoors on a muggy day in summer; yet it is a matter of experience that the outdoor temperature must be very much higher than the indoor temperature in order to produce a comparable degree of discomfort.

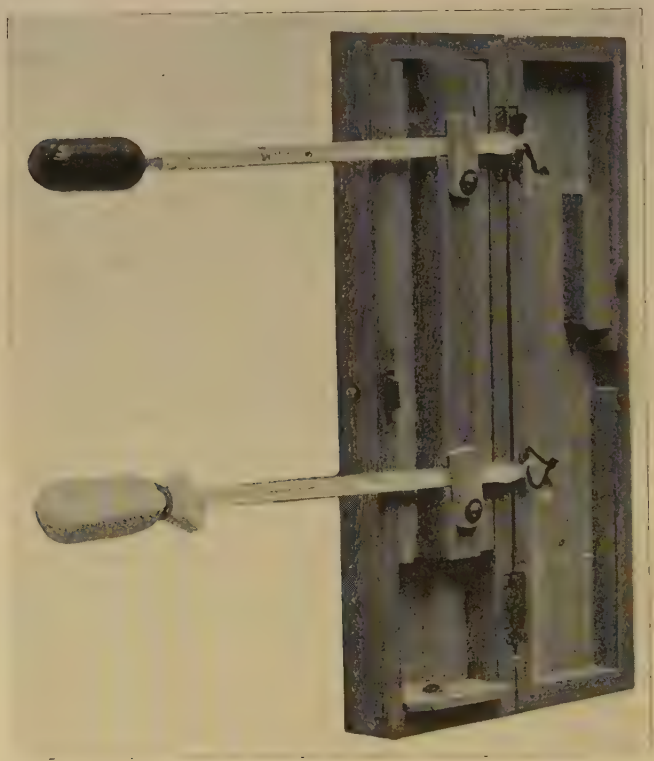

FIG. 40.—The Kata thermometer. (Courtesy, American Public Health Association.)

Dr. W. Heberden[1] pointed out these facts nearly a hundred years ago and suggested a way out of the difficulty by the observation of the rate of fall of a thermometer previously heated to a high temperature.

The same principle has recently been independently applied by Dr. Leonard Hill,[2] in England, in the instrument which he has called the Kata thermometer.[3]

[1] An Account of the Heat of July, 1825; together with Some Remarks upon Sensible Cold, Trans. Roy. Soc., London, 1826, Part II, p. 69.

[2] The Physiology of the Open-Air Treatment, The Lancet, May 10, 1913, clxxxiv, i, 283.

[3] Sold in United States by H. N. Elmer, 1140 Monadnock Bldg., Chicago (agent for Siebe Gorman Company).

The Kata thermometer outfit as first proposed by Hill consisted of two specially constructed thermometers with large bulbs and stems graduated from 86° to 110° F., one to be used as a dry and the other as a wet bulb thermometer. The bulbs are heated to about 110° and then placed in clips which hold them in a horizontal position, after drying the bare bulb on a clean cloth and jerking excess moisture off the silk covered one. The time taken to fall from 100° to 90° is then noted, best by the use of a stop-watch.

The rate of fall of both thermometers will obviously be affected by air movement and radiant heat as well as by air temperature, and that of the wet bulb by the humidity of the air as well. Dr. Hill believes that the combined influence of these factors will affect the Kata thermometers very much as it does the human body, and suggests a 45 to 60 second period for the wet bulb and a 150 to 180 second period for the dry bulb as limits for comfortable atmospheric conditions. Recent studies[1] have indicated that the lower of the limits set corresponds very closely to the average vote of a number of American observers as to bodily comfort.

Hill, Griffith and Flack[2] have recently presented a detailed study of the physical problems involved, in which the heat loss from the Kata thermometer is calculated in a more exact manner in millicalories per square centimeter per second, and the Siebe Gorman Company are now putting out instruments whose factors as compared with a laboratory standard have been determined. These new bulbs are graduated only from 95° to 100°. The factor divided by the number of seconds it takes to make this five-degree drop gives the rate of cooling at body temperature in millicalories per square centimeter per second. The wet Kata thermometer gives the rate of cooling by radiation, convection and evaporation. The dry Kata thermometer gives the rate of cooling by radiation and convection.

This instrument is a distinct improvement over the earlier patterns in that results from different instruments are now directly comparable.

Professor E. B. Phelps, of the United States Public Health Service, has devised an instrument based on the same principle, which has the great advantage of permitting of continuous records of heat loss. It consists of a wet bulb thermometer heated by an electrical coil and constant current of such a strength that in a saturated atmosphere the thermometer registers 8° higher than an unheated bulb.

Such instruments as these, which give us information as to the actual heat loss from the body surface as a result of the whole complex of atmospheric conditions, promise to be of the greatest service in the ventilation studies of the future.

Enumeration of Dust Particles.—The study of the dust content of air is of great sanitary moment in connection with certain industrial processes in which irritant or poisonous dusts are discharged into the atmosphere in considerable amounts.

[1] Winslow, C.-E. A.: The Kata Thermometer as a Measure of the Effect of Atmospheric Conditions upon Bodily Comfort, Science, N. S., 1916, xliii, 716.

[2] The Measurement of the Rate of Heat Loss at Body Temperature by Convection, Radiation and Evaporation, Phil. Trans. Roy. Soc., London, series B, 1916, ccvii, 183.

The Palmer Dust Sampler, which seems to be the best form of apparatus for this determination, combines the forces of precipitation and filtration somewhat on the principle of a commercial air washer. The air to be sampled is drawn through water in a shallow trap at such a rate as to break the water up into a fine shower of spray in the glass bulb above, this spray taking the dust out of the air and finally washing it down into the trap. After the completion of a run the dust collected in the water may be estimated by any or all of three methods: by direct microscopic enumeration in a Sedgwick-Rafter cell, by weighing after filtration through a Gooch crucible, or by comparing the turbidity of the organized suspension with a set of standards.

This apparatus (Fig. 41) was described with the technic involved in its use by Messers. Palmer, Coleman and Ward in the *American Journal of*

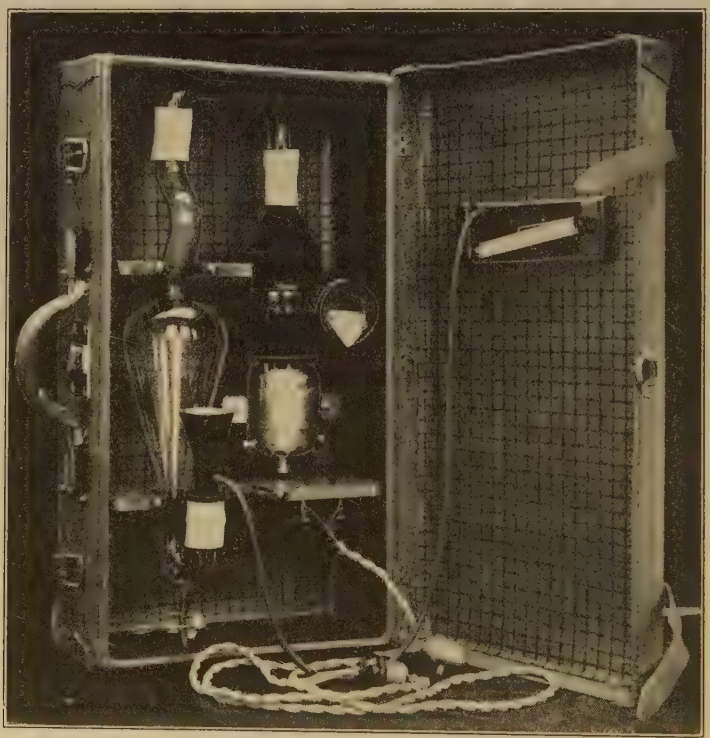

FIG. 41.—Palmer water spray apparatus for collecting samples of atmospheric dust.

Public Health for January, 1916, vol. vi, p. 54, and may be obtained from Wallace & Tiernan, of 137 Center Street, New York. The apparatus, including the motor and the Venturi meter for measuring the air, may conveniently be mounted in a light dress suit case, the whole weighing seventeen pounds or less.

The particles when counted under the microscope should be grouped in the following five classes:

1. Large masses, about 100 standard units (0.04 sq. mm.).
2. About 25 standard units (0.01 sq. mm.).

3. About 1 standard unit (0.0004 sq. mm.).
4. About $\frac{1}{4}$ standard unit (0.0001 sq. mm.).
5. Dust too fine to count—presence indicated by a plus sign.

A control should always be made, using the same slide and the same batch of distilled water, and the average of the five field counts obtained subtracted from the average of the ten field counts of the suspension of dust.

The remainder of the suspension should be filtered through a weighed Gooch crucible, the crucible and contents dried for one hour at approximately 100° C. and weighed to 0.1 mg.

Enumeration of Bacteria in Air.—The sand filter method, originally suggested by Petri, has proved the most satisfactory method for the

FIG. 42.—Filter for collecting bacteria from air. Ruehle type.

study of the bacterial content of the air. For the collection of the sample the Ruehle tube (Fig. 42) should be used. This is a glass tube of 15 mm. in diameter and 70 mm. long with a smaller tube 6 mm. in diameter and 40 mm. long fused into one end. On the shoulder at the joint between the tubes rests a plug of cotton supporting a layer of sand 10 mm. deep. The sand should be capable of passing a 100-mesh sieve but not a 200-mesh sieve. The opposite or inlet end of the larger tube is stoppered by a cork stopper (which need not be exactly tight) perforated by a glass tube 6 mm. in diameter and 40 mm. long bent at an angle of 45° to prevent direct precipitation of dust particles into the filter tube.

Five cubic feet of air should be drawn through the filter by the use of an aspirator of known volume, preferably one of the double or continuous type, or by the use of some form of pump and meter. A convenient and ingenious sampling pump was made by Wallace & Tiernan of New York City for the study by Baskerville and Winslow of the air of New York City Schools. After filtration the sand should be shaken out into 10 c.c. of sterile water, and after thorough shaking aliquot portions of the water should be quickly removed and plated on ordinary nutrient agar.

The use of lactose-fermenting streptococci as special indices of mouth pollution in the air has been suggested by Gordon; and recent studies by Nolte and Winslow and Browne indicate that it may have a real value.[1] In case it is desired to make this test the standard procedure may be used with the substitution of litmus lactose agar for plain agar. Characteristic streptococcus colonies (small, acid colonies) should be fished to agar and identified by their typical veil-like surface growth, microscopic appearance (cocci in pairs or chains) and production of acid in lactose broth. A large number of air samples must be taken in parallel as these organisms are often found only to the number of 10 per 100 cubic feet of air.

Poured blood agar plates may be used to detect hemolyzing streptococci, other streptococci and pneumococci.

[1] Gordon, M. H.: Report on a Bacterial Test for Estimating Pollution of Air, Supplement to the XXXII Annual Report of the Local Government Board of Great Britain, containing the Report of the Medical Officer for 1902-03, 1904, p. 421. Nolte, A. G.: The Identification of the Most Characteristic Salivary Organisms and Its Relation to the Pollution of Air, Ann. Missouri Botanical Garden, 1914, i, 47. Winslow, C.-E. A., and Browne, W. W.: The Microbic Content of Indoor and Outdoor Air, Monthly Weather Review, 1914, xlii, 452.

CHAPTER VIII.

HOUSING.

By LAWRENCE VEILLER.

Housing is so vital a factor in public health work that it is strange that it has not been given greater attention in recent years in the public health movement. This is in striking contrast to the early days of that movement in America when the leaders there were also leaders in the movement for housing reform. In fact the housing movement in America owes its initial impulse to the work of health officers.

Perhaps one reason for this present situation is to be found in the fact that while housing is to a very large extent a health problem, it is also an economic problem and a social problem. In times when there is a great shortage of houses due to economic reasons it is natural that the health aspects of this vital question should be to some extent overlooked. There is a small school of sanitarians in America who hold that housing is not a health problem and that housing work plays no part in the functions of the public health officer.

We are glad to say that this view is held by only a few persons.

It is strikingly in contrast with the views of the civilized nations of the world. Great Britain, for example, affords a striking illustration of the opposite point of view. There the housing problem is a political issue and one of the great public questions of the day.

While the social and economic aspects of the question are there fully recognized, its health aspects are considered paramount, as is evidenced by the fact that all functions of the Royal Government in relation to housing are vested in the Ministry of Health, which is charged with the important duty of seeing to it that 500,000 houses of a sanitary and modern type are built to meet the needs of the people of England.

Whatever theoretical views may be held as to whether housing is the function of a public health officer or not, the average health officer will find in practice that he cannot escape responsibility for it. It is thrust upon him whether he wants it or not. It is the wise health officer who recognizes this clearly and not only accepts this responsibility, but responds to it adequately and enthusiastically.

Every health officer knows that there is no way by which he can escape responsibility for what is known as the usual "nuisance" work, a term given not to designate the feeling of the health officer toward it, but to describe the class of work involved, namely, work dealing with the abatement of nuisances which is the beginning of all health work. In truth, the necessity for attention to such matters is what calls into

being a health department in most communities. Responsibility for it can no more be evaded than can responsibility for reducing the infant death-rate.

WHAT HOUSING IS.

Perhaps one reason for the point of view just discussed—that housing is not part of the work of a health officer—is to be found in the fact that the people holding that view have not clearly had in mind how all-embracing a subject housing is, and how many of the phases of the recognized activities of health departments are included under this term. Of the 30 phases of public hygiene discussed in this volume in 30 different chapters, I note at least 12 of them into which housing directly enters as an important factor. It concerns itself vitally with the ventilation and heating of buildings, with sewage disposal; with infectious diseases; with the relations of insects to human diseases; with personal hygiene; with public health education; with water supply; with military and camp hygiene and even with personal hygiene.

Even on its economic side it may have a very important bearing on health. Where a serious shortage of houses develops, the resultant overcrowding of rooms becomes a most serious factor in the extent and spread of such contact diseases as influenza, poliomyelitis and measles.

The relation of improper housing to health is to be observed in two ways—the direct effect and the indirect effect. The latter is to be seen in the general lowering of vitality and power of resistance to disease of the individual caused by bad living environment.

TUBERCULOSIS.

One of the most direct relations between bad housing and disease is that between the dark room evil and tuberculosis.

Though we have known for a quarter of a century the essential facts about the control of tuberculosis and its prevention; though we have known that a person ill with this disease has practically no chance of recovery if living in a dark or badly lighted room; though we know that the tuberculosis germ retains vitality for many months in dark rooms; though we know the germicidal effect of direct sunlight upon such germs in destroying them and making them harmless in a few moments, yet the state or city in this country which forbids the erection of dwellings with dark rooms in them is the exception rather than the rule.

Literally, one can count on the fingers of one hand the states throughout this country which have taken such action. What does this mean? It means that we are stupidly today spending vast sums of money—millions of dollars—to cure and patch up, so far as we can, the victims of this disease which still claims one-tenth of all who die, while at the same time we are permitting, without restriction, new conditions to be created in every city, town and village throughout the land that make success in our efforts to cure these sufferers impossible. We are

deliberately manufacturing—if one may put it that way—new cases of the disease literally by the thousands; for, every tenement house and common lodging house and dwelling house that is built with rooms that are insufficiently lighted is a potent factor in the future development and spread of the disease.

And the reason this situation exists is because the health officers of the country have failed in the past to recognize fully their responsibility with reference to housing and have been content to leave so troublesome a question as the proper regulation and control of the construction of buildings to others. No better illustration could be had to evidence the fact that housing is essentially a part of public health work.

Through the neglect of the health authorities to supervise the construction of new dwellings and other buildings in which people live, the conditions just described have developed. Building inspectors have shown conclusively that such questions cannot be safely left to them for determination, and it is not strange that this should be so. Why should a builder be interested primarily in health matters? And why should he be expected to have a knowledge of the close relations that exist between insufficiently lighted rooms and the extent and prevalence of such diseases as tuberculosis. The average builder is concerned only with getting a profit out of the house that he builds, and if he can market his house he cares little as to whether it is a healthy house or not.

We have spoken only of the direct effect of insufficiently lighted rooms in their relation to one disease—tuberculosis. The indirect effect on health of such conditions is incalculable. Probably no one factor will so quickly lower vitality and the power of resistance to disease as the constant dwelling in dark or dimly lighted rooms; for, darkness is inseparably connected with dirt and disorder. They go hand in hand. Where rooms and hallways and cellars and other parts of dwellings are dark, conditions of neglect and filth and disorder are not so readily visible and therefore are likely to flourish; that dirt is a factor in ill health cannot be gainsaid.

The brilliant and able former Health Officer of the State of Pennsylvania for so many years, the late Dr. Samuel G. Dixon, fully recognized this. In an address delivered not long before his death, entitled "Proper Housing Means Cleanliness," he had this to say on this subject:

"In order to have the abiding places of men healthful, we must have them clean—yes, clean in the broadest sense. We must have clean air—that element which affects life more quickly than anything else; we must have clean water, which next to air is most necessary to our lives; we must also have clean food, clean bodies, clean dress, and clean houses, none of which can be maintained without clean air and clean water. . . .

"Housing or the abode of man in its broadest sense cuts a wide swath in the field of hygiene. Public and personal hygiene are so intimately associated that they are often interlocked so that each depends upon the other. . . ."

VENTILATION.

Light and ventilation are so commonly associated in the public mind that it is a little hard to dissociate them. Whether dark rooms or unventilated rooms are the more serious factor in tuberculosis is hard to say, for the two are generally interwoven. The room that is insufficiently lighted is generally insufficiently ventilated; for, as a rule, it means that it has not the proper windows opening on the proper open spaces, though there are, of course, cases where artificial ventilation is achieved in certain classes of buildings where there is not adequate lighting.

Close, stuffy rooms probably quite as much as darkness, lower the power of resistance of the individual and reduce his vitality. In summer in warm climates they exercise a most baneful effect.

Reverting once more to the view that housing is not part of a health officers' functions, one cannot help but inquire how a health officer is to achieve proper conditions of ventilation if he does not concern himself with housing. We have learned in recent years that the three great factors in what may be termed proper ventilation are moving air, the prevention of too high a temperature and the prevention of excessive moisture.

Just how moving air is to be achieved in the homes where most of us spend the greater part of our time—certainly in most cases twelve out of the twenty-four hours—if there are no windows in the rooms in which we sleep to let in the air, or if the houses or apartments which we occupy have been so designed that cross or through, ventilation is impossible, is not apparent. Similarly, how we can reduce excessive temperature in rooms in the tropical weather which prevails in many parts of America in summer time, if there are not windows in our rooms to let out the heated air is also a puzzle. It is singular that health officers should recognize their responsibilities with reference to the ventilation of public buildings and public conveyances such as theaters and street cars, as most health officers have come to do, and yet should fail to recognize their equal responsibility with reference to the homes of the people.

While the heating of rooms is in no sense so important a question as their ventilation, the lack of sufficient heat in our extreme winter weather in some parts of the country does become a very serious factor in the health of that community; for, where houses are improperly heated and the control of the conditions is not within the power of the tenant, as is the case in many of our large cities where apartment houses and tenements are the rule, then a really serious situation may result; for, nothing will work so great a detriment to a person's power of resistance, or will so quickly render one a prey to influenza and pneumonia as living in rooms that are insufficiently heated.

Health officers heretofore have given little or no attention to this subject. They have exercised no control over the installation of proper heating plants and have only recently commenced to enforce

ordinances or amend sanitary codes by requiring landlords to maintain 70 degrees, or some similar standard in winter weather. This is as far as they have gone. Even what seems so apparently remote a subject as the heating of buildings has come to be an important factor in the health of the community.

ROOM OVERCROWDING.

No phase of the housing question has so direct a relation to public health work as the prevention and control of room overcrowding, and no phase of housing has been so generally neglected heretofore in this country. Practically no community in the United States has done anything effective to control or regulate this serious evil.

How important it is has been disclosed to the country in the epidemics of poliomyelitis and influenza in recent years. Both of these epidemics, especially the various influenza epidemics, would have spread to less extent had it not been for the crowded conditions of living which prevail in many of our cities caused by the shortage of housing accommodations due to the war. Here the relation between the disease and housing conditions is almost in direct arithmetical ratio. It would hardly seem necessary to argue that in the control of contact infection people should not be allowed to sleep and live four, six or eight in a room and that the amount of air space, the frequency of renewal of the air and the other factors which enter into adequate ventilation should be observed.

A study made by the New York City Health Department in 1916 of the relations between room density and communicable diseases showed this most clearly.

It was found that where there was less than one person to each room the percentage of cases of colds, tuberculosis and other diseases spread by contact was 8.18 per 1000 of population; where people were living from one to two persons per room the rate of infection was greater, viz., 8.27 per 1000; where there were two to three persons in a room, it was 8.62; and where there were three to four in a room it was still greater, viz., 9.36 per 1000.

Just how the school of thinkers who advance the view that housing is not a part of public health work believe that health officials can control the spread of epidemics like influenza and poliomyelitis and measles, if they have no power to reduce room-overcrowding, one is puzzled to understand. And if it is not appropriate for the health officer to reduce crowding in a room in which people live, why should he reduce crowding in a room where people sit to be amused? The point of view hardly seems logical, and indeed it isn't.

PRIVY-VAULTS.

One of the most serious housing evils that exists in the United States today is the existence in very large quantities of the disease-breeding,

antiquated and obnoxious privy-vault in various forms. No one knows just how many vaults there are in the United States, the Federal Health Service never having attempted to find out, but that they exist by the hundreds of thousands and probably by the millions, there can be no doubt.

In sparsely settled communities where there is no communal water supply the privy-vault is, of course, a necessity. In large cities and small towns, however, where there is a water supply, the vault is not a necessity and should not for a moment be tolerated.

It still exists in such communities to an unbelievable extent. Less than ten years ago an inquiry made in 40 cities showed that in a city of 350,000 population there were then 60,000 individual privy-vaults and that 50,000 of these were located where sewers were available. In another city of 490,000 population it was disclosed that there were 27,000 privy-vaults of which 20,000 were located where sewers were available.

Before the discovery of the insect as a disease carrier, the privy-vault was regarded as a nuisance and something unpleasant because of its noisome odors, but since the discovery of the typhoid fly, the privy-vault has assumed a different aspect as a potent source of disease. No community can hope to rid itself of typhoid fever if it allows privy-vaults to exist; for, fly infection is sure to result sooner or later.

A study of the relation of typhoid fever to the presence or absence of sewerage systems, made by the New York State Health Department in 1918, and embracing the records of twenty years showed this conclusively. The typhoid death-rate had a 26 per cent. excess in the unsewered communities.

Of the effect of the vault, when present in close proximity to the living quarters of the people, in lowering bodily vitality and reducing the power of resistance to disease, it is unnecessary to speak; that it plays an important part in this respect is without question.

Merely connecting existing vaults with sewers and thus turning them into "school-sinks" as they are called in some parts of the country, or "catch-basin privies" as they are called in other parts of the country is a makeshift that in no sense solves the problem and an expedient that should not be tolerated. The sewer-connected privy is just as dangerous as the ordinary privy with the exception that the element of pollution of the water supply, where there are wells, has been eliminated; but as privy-vaults can only be sewer-connected where there are sewers, and sewer systems exist only where there is communal water supply this factor is of no moment.

Every community that calls itself civilized should get rid of its privy-vaults in whatever form they exist at the earliest possible moment and should insist upon their replacement by modern water-closets located inside of the house and properly sewer-connected. Where there is no sewer but a communal water supply exists, it is far better to have septic tanks or cesspools constructed and to have the water-closets drain into these than it is to continue a system of privy-vaults.

Where privies are necessary in rural communities because of lack of water supply, the only type of privy that should be tolerated is the modern, sanitary fly-protected one.

If housing is not part of a health officer's work, how is the health officer to eliminate malaria by doing away with the places in which mosquitoes breed; for, without proper drainage of the surface around each house there will be standing pools of water, each one of which will be a fertile breeding ground of mosquitoes. The constant inspection of rooms and dwellings for the elimination of vermin plays its part in the prevention of disease; for, vermin is a carrier of disease, even the obnoxious bed-bug playing an important part in spreading disease of various kinds. Such things therefore as the elimination of wall paper from the homes of the poor and the substitution of sanitary, painted, or kalsomined walls is a matter that should concern every health officer. Similarly, in large cities where tenement houses prevail the sealing of openings in floors through which steam pipes and plumbing pipes pass is essential in order to prevent the passage of vermin from floor to floor and from apartment to apartment.

WATER SUPPLY.

How great a factor an adequate supply of pure water is in the health of the community is so well recognized that it is unnecessary to comment on it. Merely ensuring the purity of the source of that supply is not sufficient. What is necessary to be done is to make sure that all members of the community obtain the use of it freely and easily. It is especially important that its use should be made easy to those members of the community who are most in need of it, namely, the poor, and no obstacle should be placed in the way of their having a generous supply at all times. Personal hygiene depends upon it. It is all very well to ask people to bathe frequently but if all the water that can be obtained has to be drawn from a pump or hydrant in the back yard down three or four flights of stairs and then must be carried up those stairs in buckets or pails, bathing is not likely to be achieved. So also with cleanliness of the home. Where water is obtained with difficulty—and in many of our cities this still is the situation—cleanliness of the home is not likely to be found and disease is quick to breed in the conditions of dirt and filth which result. The health officer therefore, if he wants to insure an adequate supply of water to the householder, must concern himself with housing and must see to it that all existing houses are equipped with running water with sinks or wash bowls, conveniently located and easy of access to each tenant, and must also see to it that in new houses every family is supplied with its individual water supply. In the larger cities where the taller tenements prevail the street pressure is sometimes insufficient to cause the water to rise to the upper stories of such buildings. In such cases the health officer will find it necessary to compel reluctant landlords to supply pumps or other appliances so that the tenants of the upper stories may be provided with an adequate water supply.

VENEREAL DISEASE.

So remote a subject as venereal disease enters into housing; for, one of the possible methods by which venereal disease is spread is through the common water-closet; most so-called "innocent infections" outside of the marriage relation arising in this way.

More and more clearly the health officers of the country are beginning to realize that irrespective of any moral question involved it is their function to grapple with the problem of venereal disease as one of the serious communicable diseases affecting the health of their community.

If it is true that the common water-closet with its promiscuous use is a factor in spreading venereal disease, then it is clear that the health authorities of a community ought to see to it that such conditions are not repeated in the future and that new dwellings are not erected in which the people who live in them are dependent on the use of a common water-closet used by several families. They should also, as rapidly as possible, eliminate the existing common water-closets and insist upon it that individual water-closets with due privacy are provided for every family.

We have discussed at some length the main factors in the housing problem from the point of view of health and have alluded only to those that act in a direct and obvious way. There are many other factors, however, which enter into the situation which are of greater or less importance and which should not be lost sight of. Take for instance, such a question as the providing of individual water-closets inside of the apartment, convenient of access to each family in place of a privy in the back yard. The effect of toilet accommodations thus remotely and inconveniently located is to discourage use. It produced therefore bad personal habits resulting in constipation and often in appendicitis. Another instance is the effect which stairs that are too steep have upon the health of women, especially where women are about to be confined. Here again it is evidenced that if the health of the community is to be maintained health officers must exercise control over buildings in many respects.

THE PLACE OF HOUSING IN HEALTH DEPARTMENT ORGANIZATION.

We have seen from what has been said that housing does vitally concern the health officer and does play an important part in his work. Let us consider now, briefly, the place that it should occupy in the proper organization of a health department. The defects of the present methods of health organization from the point of view of housing are:

1. The average health officer has little knowledge of the sanitary evils that exist until his attention is called to them by the complaint of some citizen. In most communities inspection of dwellings and the surrounding out-premises is made solely on complaint. There is no

adequate system of complete sanitary inspection at regularly stated periodic intervals for the purpose of discovering sanitary evils and remedying them promptly. Such a system of periodic sanitary patrol is the only system of sanitary inspection that is worthy of the name of system. The present unfortunate methods which are a relic of earlier and simpler days, mean that frequently the most serious sanitary evils are overlooked and neglected while attention is given to some trivial matter because of the insistence of the citizen complaining.

2. Another serious defect of the present scheme of organization is to be found in the lack of knowledge which the health officer has of the continuing history of the buildings in his community that are in themselves dangerous or detrimental to health. Few health departments' record systems are so organized that the health officer can tell at a moment's notice the complete history of any particular building in that city from the point of view of health. He should be able to do so. He should not only be able to know upon inquiry how many cases of typhoid, of tuberculosis, of diptheria, of scarlet fever have come from a given building, but he should have his records so organized and his system so perfected that by a system of signals, whenever there is an undue amount of disease in any building, this fact will automatically be called to his attention so that the building may be made the subject of special study to determine the reasons for the conditions and to take steps to remedy them.

3. Every modernly organized health department recognizes that the pulse of the organization is its Bureau of Records. Such a bureau should contain in card form two main classes of records, one class giving the health and disease record of every building in that community; the other giving the health and disease record of every person in that community, starting before birth, where possible. Some cities are beginning to do this; for, with the prenatal work that is now becoming so important a factor in reducing infant mortality, records are being obtained of the child before it is born and the child's history is being carried through from early infancy through its school period and ultimately on into adult life. No health department can consider itself properly equipped that does not have a central bureau of records containing in card form these two broad classes of information.

4. Another defect of our present methods of health department organization, from the point of view of housing, is to be found in the fact that, because of the usual absence of proper records, the health officer does not know where the places are that need his greatest attention. He is therefore unable to concentrate his attention upon the places that need it most. As a result the whole city is divided up into geographical districts and all districts are treated alike. This is a serious economic waste and with the limited resources and equipment which most health departments are working with, one of the reasons why more is not accomplished in reducing death-rates and preventing disease. What a futile waste of time it is to send visiting nurses to the homes of the average citizen who, as a rule, needs no such visitation,

when three blocks away families are suffering for lack of it and the health of the community is being endangered thereby.

In cities of vast size where the poorer districts are clearly differentiated from those where the mechanics and better paid artisans dwell, this difficulty is not so keenly felt, for it is possible there to concentrate activity upon a fairly well defined area; but in the average community such clearly differentiated districts do not exist, and it is of very great importance for the health officer to know accurately the individual houses and families that most need his attention so that he may give it to them.

5. The average health officer is still in most cities without adequate legal powers. In most communities his legal powers are limited to the abatement of nuisances, but if he is to cope with housing evils his powers must go much further than this. He must have the power to vacate a building where it is in a condition that is dangerous or detrimental to health and such power must be a summary one—one that he can exercise, if necessary, on twenty-four hours notice without the necessity of application to the courts with the possibility of long legal delays. He must have the power to stop the erection of a new building that is fundamentally violating sanitary requirements. He must be free to go in, if necessary, and hire workmen and do the work through his own agents if necessary to remove unsanitary conditions. Where, for instance, some foul privy exists and the owner is unwilling to remove it, the health officer should be free to hire workingmen and remove the privy himself, charging up the expense of such work against the property. The power to imprison, after conviction of course, violators of the health laws should be given everywhere. In many communities the health officers' power is limited to the imposing of small fines or the collection of small penalties through the minor courts. Every health officer should have available the services of a competent legal adviser devoting the greater part of his time to the prosecution of the health departments' work.

6. Finally, if the city is to be made a healthy city, the health officer must be able to prevent the creation in new buildings of sanitary evils. This means that he must have control over the plans of all new dwellings, in fact he should have such control over the plans of all new buildings, for buildings other than dwellings, work shops, theaters, office buildings are vitally concerned with questions of health.

We have said that an efficiently organized health department should ultimately have a complete record of every person, starting before birth where possible. We are tempted to say that a health department should have the records "before birth' also of every building. The time to correct defects in buildings, from the sanitary point of view, is when the plans are made and before the buildings are erected, not after they are up. Then, as a rule, it is too late. It should not be possible in any city to erect a new building until the plans for that building have had careful examination by the health department and had the approval of the health officer.

The cities where this is the practice today are the exception rather than the rule and such an important change in procedure will encounter strenuous opposition from building interests and building inspectors.

That this view has excellent authority behind it is to be found in the fact that it is held by such men as Dr. George B. Young, for a number of years Health Commissioner of the city of Chicago and a member of the U. S. Public Health Service. In a report on conditions in Charlotte, N. C., in 1917, he says:

"Building inspection has hitherto been almost wholly concerned with provisions for securing structural integrity. The questions of light, air space, ventilation and sanitary construction have had scant attention, although much the most important. A few people may suffer if a roof sags; thousands suffer daily from bad ventilation. The building inspection should be a part of the Health Department, or at the very least that Department should have an effective part in building regulation."

This is but a forerunner of a broader conception of public health activities and of the functions of health departments expressed by Assistant Surgeon General W. S. Rucker of the U. S. Public Health Service. As recently as 1917, in an article entitled "A Program of Public Health for Cities," he says:

". . . Health departments, for the most part, operate in end-results. Under the present system disease must appear before it can be attacked, the municipal policy being one of eradication rather than prevention. This is to be expected in cities which maintain fire departments for the purpose of extinguishing fires rather than to prevent them, and under this system it would be more logical to call the health department the disease department. . . ."

". . . The essential element in a public health program for cities is a definite public health policy which shall bring the health agency into close touch with every activity of communal existence. Not a policy which endeavors alone to prevent those diseases which are caused by vegetable and animal parasites, but one which aims at the control of that greater body of destructive agencies, human parasites. Not a policy which tries to control the insanitary tenement yet leaves out of consideration the cupidity which fixes its rent, but a public health policy which shall embrace the entire political economy of disease, a policy which shall be as broad and far reaching as human nature, since after all, human nature is the groundwork from which arises the fabric of the public health."

Surgeon-General Rucker even goes so far as to hold that no legislation should be enacted by the city council without the advice of its health department. He says:

". . . No legislation should be enacted by the city council without the advice of its health coördinating focus. To it the executive branches of the city government should refer all plans and matters of policy in order that all may be integrated for health. The direct and indirect authority vested in this office is great and far-reaching. . . ."

"Since concentration is inversely as the transportation facilities, the health department should be the first to be consulted in any plans for the increase of rapid transit. All of the problems connected with streets, with housing, industrial conditions, playgrounds, parks, schools, all of these bear an intimate relation to health and as such should come within the purview of the health commissioner. . . ."

ENVIRONMENT AS A FACTOR.

Thus far we have discussed what may be termed the more direct and obvious relations between bad housing and disease and lowered physical condition.

There is a larger aspect to the question than this. It is the whole broad question of proper environment; of the influence on morale; of the power of resistance to disease; of the mental and physical equipment of the individual; of the effect of living a drab and sombre existence in sordid surroundings. When one's physical outlook on life is on some filthy alley, piled high with the castoff refuse of humanity, noisome with odors, and when as far as the eye can reach there is nothing but sordid stretches of drab unpainted, dilapidated uninteresting buildings—one vast waste space, it is not strange that one's mental outlook on life should be very much the same. How we can expect either a healthy body or a healthy mind in people who have that kind of environment day in and day out is beyond understanding.

That the providing of the right kind of environment can materially change the health of a community has been proved in most striking fashion in recent years by the Garden City and Garden Village developments of England. Some years ago a soap manufacturer, William Lever, wishing to obtain a contented and stable labor supply for his soap factory located on the outskirts of Liverpool determined to build a model community in which his workers might live, each family in its own individual house with sunshine and fresh air on all sides of it; with trees and grass and gardens; with opportunities for rational social life and recreation, both for child and man. Actuated by this conception there was established the famous village of Port Sunlight on the outskirts of Liverpool, the precursor of the later Garden City and Garden Village developments of England. Port Sunlight, which drew its population from the poor quarters of the neighboring city of Liverpool, has now been operating long enough to enable one to measure the results of this kind of environment. In George Cadbury's book on "City Planning" some striking figures are presented showing the effect of such environment upon the children in Port Sunlight and in Mr. Cadbury's own similar village of Bournville as contrasted with the neighboring city of Birmingham.

In a careful study of conditions children were taken at different age periods and weighed and measured, boys separately from girls, and all taken from the same social status or rank in the industrial community. It was shown from this study that boys of 6 years of age from the

Garden Village of Bournville weighed 45 pounds as contrasted with 39 pounds, the weight of the boys coming from St. Bartholomew's Ward of the neighboring city of Birmingham, only twenty minutes away. At 8 years the Bournville boys weighed 52.9 pounds as compared with 47.8 pounds in Birmingham. At 10 years of age Garden Village boys weighed 61.6 pounds as compared with 56.1 pounds in Birmingham, and at 12 years of age the Garden Village boys weighed 71.8 pounds as contrasted with 63.2 pounds in Birmingham. Similar variations were found with the weight of the girls. For example, the Garden Village girls of 8 years of age weighed 50.3 pounds as compared with 45.6 pounds in Birmingham.

Similar measurements as to height showed similar results. Garden Village boys from Bournville at 6 years of age measured 44.1 inches as contrasted with the Birmingham boys of that age who measured but 41.9 inches. Eight-year-old boys of the Garden Village measured 48.3 inches compared with a height of 46.2 inches for the Birmingham boys, and so it went through all other age periods. Similar facts were disclosed with reference to the girls.

The following statement in tabular form shows the above facts in detail:

WEIGHT.

	Age 6 years. Pounds.	Age 8 years. Pounds.	Age 10 years. Pounds.	Age 12 years. Pounds.
Boys—Bournville (Garden Village)	45.0	52.9	61.6	71.8
Boys—St. Bartholomew's Ward, Birmingham	39.0	47.8	56.1	63.2
Girls—Bournville (Garden Village)	43.5	50.3	62.1	74.7
Girls—St. Bartholomew's Ward, Birmingham	39.4	45.6	53.9	65.7

HEIGHT.

	Inches.	Inches.	Inches.	Inches.
Boys—Bournville (Garden Village)	44.1	48.3	51.9	54.8
Boys—St. Bartholomew's Ward, Birmingham	41.9	46.2	49.6	52.3
Girls—Bournville (Garden Village)	44.2	48.6	52.1	56.0
Girls—St. Bartholomew's Ward, Birmingham	41.7	44.8	48.1	53.1

DEATH-RATES.

	Infantile death-rate per 1000 births.	Ordinary death-rate per 1000 births.
Bournville (Garden Village)	55.0	4.8
Letchworth (Garden City)	50.6	6.1
Hampstead (Garden Suburb)	62.0	9.8
Bournemouth	70.0	9.9
Lewisham	62.0	10.4
Hammersmith	90.0	13.1
London	101.0	13.6

When it came to death-rates similar striking statistics are shown. The infantile death-rate per 1000 births in the Garden Village of Bournville was 55.0 as compared with 101.0 in London, and the general death-rate per one thousand births in the Garden Village of Bournville was reduced to the amazingly small rate of 4.8 contrasted with the death-rate then prevailing in London of 13.6. Some years later there

was established that extraordinary community known as the First Garden City located at Letchworth, England, where not only the ideal conditions of living which have been described as prevailing at Port Sunlight and Bournville are to be found, but in addition a self-contained community was established with sufficient industries to support the members of that community. Letchworth has now been established long enough to make similar statistics available. I need refer to only one statement to show what extraordinary results have been achieved. It is this:

"The infant mortality figures for 1917 show the death-rate in Letchworth to have been 36 to the thousand, while in 96 large urban centers it was 104 to the thousand."

So much for the infant death-rate. When the general death-rate in London was 13.6, the general death-rate in Letchworth was only 6.1. One might go on almost indefinitely adducing similar facts.

HOW TO ACHIEVE GOOD HOUSING.

If housing plays so important a part in public hygiene and in the work of the health officer, it may be asked "How are good housing conditions to be achieved?" There are two methods. The chief one is—

1. By Legislation and Law Enforcement.

The second one is—

2. By Public Education and by Holding up the Right Standards.

Health officers and public-spirited citizens interested in the health of the community should seek the enactment of housing legislation[1]. By that is meant laws, and preferably *State* laws rather than local ordinances, which will insure that all future dwellings erected in that community shall be fit places to live in; that there shall be no dark rooms in them; that rooms and halls shall be not only well lighted and ventilated but shall secure as much direct *sunshine* as possible; that there be convenient and adequate water supply, proper methods of waste disposal; that rooms shall be of adequate size; that buildings of undue height shall be forbidden; that buildings shall not be crowded too close to each other; that foul and filthy outpremises shall be done away with; that dangerous and disease-breeding privy vaults shall be eliminated—in a word, that the homes and dwelling places of the people shall be safe and sanitary and these conditions shall apply not only to the dwellings that may be erected in future, but shall, so far as practicable, be made to apply to all of the existing dwellings in that community. It must, however, be a *housing* law and must apply to all buildings in which people live, to hotels and lodging houses, boarding houses and rooming houses, clubs, asylums, hospitals and even jails.

[1] Health officers will find in "A Model Housing Law," revised edition 1920, Russell Sage Foundation, 130 East 22d Street, New York City, a ready-made housing law which can be easily adapted to suit local conditions. They will also find that this book serves as a set of standards as to the conditions that should prevail in their community.

It must provide for the supervision of all dwellings by the health authorities at reasonably frequent intervals. It must contemplate compulsory alteration of the older houses where necessary and where practicable.

The other method by which good housing conditions can be achieved is through public education; by holding up the right standards to the community. Bad conditions which prevail in so many of our cities today are due largely to the fact that people have not had proper standards. They have been due to ignorance and neglect much more than to greed. How many builders realize the fundamental principles of ventilation or sanitation? How many architects even have kept themselves in touch with the latest and most modern developments in that science? We can confidently say very few. By holding up to the men who are responsible for the creation of buildings the right standards; by impressing not only upon the architect and builder, but upon investors and upon the financial interests in the community that finance the production of buildings what the right standards are that should prevail, the health officer can accomplish much; even more, perhaps, by bringing home to the entire community the importance of such standards so that the day may come when people will no longer be content to live in the dreary monotony of the average city street, but will insist upon a wholesome and attractive environment; will demand that the places where they live shall be like Letchworth—with its death-rate of 6 to the thousand, and not 14 to the thousand as in most cities.

That housing presents many difficulties will be no discouragement to the progressive and intelligent health officer; for, it is the difficult tasks that are the most interesting ones.

Nor should a courageous health officer be deterred by the fear of the opposition that he will encounter from interested property owners. That such opposition will be encountered there can be no doubt, but the health officer should approach his task bearing in mind the words of Elihu Root:

"There never was a reform in administration in this world which did not have to make its way against the strong feeling of good honest men, concerned in existing methods of administration, and who saw nothing wrong. It is no impeachment of a man's honesty, his integrity, that he thinks the methods that he is familiar with and in which he is engaged, are all right. But you cannot make any improvement in this world without overriding the satisfaction that men have in things as they are, and of which they are a contented and successful part."

CHAPTER IX.

FOOD.

By EDWARD K. DUNHAM, M.D.

There are several ways in which food is important to health. It is self-evident that it should be wholesome in quality, suitably prepared and in adequate quantity and variety to meet the needs of the individual consumer. While some of these requirements are not easily defined in an accurate way, knowledge of these matters has made very considerable advances within recent years.

The decision of some of the questions which arise in connection with the choice and quantities of food consumed must rest with the individual. It is not unimportant that his taste should be gratified in his selection of dishes, provided that taste has not been vitiated by unwise habits or indulgences. The distribution of the daily ration among meals differing in abundance and character will also depend upon individual preferences, experience and convenience.

There are other matters, at least in cities, which are beyond the control of individuals. These are properly cared for by municipal, State or Federal authorities, and the legal regulations within this field have been greatly extended during the past generation.

Because in some respects they are the clearest and most definite, it is well to consider first certain quantitative needs of the human being for food. These rest upon the demands entailed by growth, the maintenance of body structures and the amount of energy expended in the total activities of the individual.

Food, the Source of Bodily Energy.—In the common affairs of daily life, when there is need of either heat or power, recourse is had to the burning of some form of fuel. The chief chemical elements concerned in the combustion of commercial fuels are carbon and hydrogen, whether coal, wood, or any other fuel is the one employed.

Within the body similar processes of combustion or oxidation liberate heat or other forms of kinetic energy which are utilized to maintain the activities of life. The fuel elements are the same, being the carbon and hydrogen entering into the composition of foods and the end-products, when oxidation is carried to completion are in all cases carbon dioxide and water.

Since the energy required by the body is derived from food constituents by chemical cleavages in which oxidation plays a prominent part, a study of foods would manifestly be incomplete without a consideration of their fuel or "calorific" values.

The Heat Unit or "Calory."—In discussions involving quantitative relationships, it is necessary to select some applicable and convenient

unit of measurement in which the quantities under consideration can be expressed. All forms of energy can be expressed in terms of *heat*, for they can all be transformed into this particular manifestation of energy, and this is a convenient form for measurement in studies of metabolism. The unit of heat is the calory, defined as the amount of heat required to raise the temperature of one liter (kilogram) of water one degree centigrade.[1] The mechanical equivalent of this unit is 423.985 kilogram-meters, or, approximately, 3063 foot-pounds. A further conception of the magnitude of this unit may be gained from the knowledge that 12.5 grams of carbon or 3.4 grams (38 liters) of hydrogen yield 100 calories when burned, and this is the case whether the combustion be rapid or slow, though the *temperature* at which the oxidation takes place will vary. This amount of energy, could it be applied without loss, would suffice to raise 15 tons one foot, or nearly 6 pounds a height of a mile.

Foodstuffs as Fuel.—Proteins, carbohydrates and fats all contain both carbon and hydrogen and, in consequence, are sources of energy when consumed in the body. But the proteins are not so completely burned as the other two classes of foodstuffs, since the end-products of nitrogenous metabolism contain carbon and hydrogen which have not undergone complete oxidation. A distinction may therefore be drawn between proteins on the one hand and carbohydrates and fats on the other; the latter being regarded as primarily fuel foods, while the proteins are of essential value in tissue production and maintenance, being the source of the amino-acids entering into the composition of the body proteins.

Isolated carbohydrates and fats contain only carbon, hydrogen and oxygen. Of the two groups, the carbohydrates contain more oxygen (53.33 per cent.) than the fats (10.75 per cent. to 12 per cent.) and are therefore less rich in the fuel elements.

While there are variations within each of the three groups of foodstuffs, as a basis for calculations the calorific values may be taken at: for one gram of protein or carbohydrate, 4.1 calories; for one gram of fat, 9.3 calories. These figures apply only to the purified food constituents of each class when free of water.

With perhaps the single exception of refined sugar, foodstuffs are not commonly available in such isolation. Practically all the natural foods of daily life are mixtures of the three classes of foodstuffs in various proportions. Nevertheless it is possible to calculate the fuel value of a given natural food without recourse to a complete separation and determination of these constituents. Considering the complexity of their composition, comparatively few data are required as a basis for calculating the combined fuel values of the constituents with sufficient accuracy for dietary purposes.

The important analytical determinations are:

1. Water; the percentage loss of weight on complete drying at 105 to 110 centigrade.

[1] This is the "large calory" which is 1000 "small calories," the heat required to raise the temperature of one gram of water one degree centigrade.

2. Fat; the weight of an ether-extract from the dried substance, calculated as percentage of the original sample.

3. Nitrogen; usually determined by the Kjeldahl method.

4. Ash.

5. Carbohydrates; determined by the hydrolytic conversion of starches into sugar and estimating these through the reduction of copper salts. But in many cases the carbohydrates may be estimated by difference with sufficient accuracy for ordinary needs.

The protein content of the food is taken as 6.25 times the nitrogen.

In using data obtained in this way for calculating the calorific value of a natural food, an allowance is made for inaccuracies due to ignoring indigestible ingredients and including nitrogenous substances not protein in nature with those that are protein. These allowances lead, in practice, to the use of the following factors: 1 gram of protein or carbohydrate, 4 calories; 1 gram of fat, 8.9 calories.

CALCULATION OF FUEL VALUE AND COST BASED ON AN ANALYSIS.

Water . . .	25.08			
Protein . . .	10.95	(N = 1.752) . . .	x 4.0 =	43.80 calories
Fats	.853	. . . . .	x 8.9 =	7.59 "
Ash	1.635			
Carbohydrates .	61.482	(by difference) . .	x 4.0 =	245.93 "
	100.000	100 gm. bread		297.32 "

Average weight of a loaf, 355 grams; maximum, 370; minimum, 345. Cost, 5 cents. Total calories in average loaf, 1055 (2.97.32 × 3.55). Cut into 20 slices $\frac{1}{3}$ inch thick, each slice would be equivalent to 52.25 calories at a cost of $\frac{1}{4}$ cent.

One hundred calories = 33.63 grams of bread (100 ÷ 2.9732), costing 0.474 cents.

Directing attention to the protein, the whole loaf contains the fuel equivalent of 155.49 calories (43.8 × 3.55) and to obtain 100 calories from this constituent 228.3 grams of bread must be consumed; over half a pound and nearly two-thirds of the whole loaf, at a cost a little over 3.21 cents, which, however, would also include 578.8 calories derived chiefly from carbohydrates.

Nutrient and Fuel Needs of the Body.—It is convenient to make a distinction between those foods which furnish materials essential to maintain the structure of the body, those which are predominatingly sources of energy and those which serve as adjuncts of importance in conserving health. For the sake of brevity, these may be designated as "nutrient," "fuel," and "supplemental" groups.

The nutrient group of foods is made up chiefly of proteins. These differ to some extent in the variety and relative proportions of the amino-acids they contain, as well as in other respects. The proteins of animal origin, meat, fish, eggs, milk and its products, are somewhat preferable for human consumption than are the vegetable proteins, but the differences are not very great and a relatively small proportion of the better proteins suffices to correct any deficiencies in those derived from the vegetable kingdom. When estimated in calories, about 10

per cent. of the total food intake should be protein. People habitually consume considerably more than this and growing children actually require a larger proportional amount to encourage development.

The fuel group of foods is made up chiefly of carbohydrates and fats, although proteins have a fuel value equal to that of carbohydrates. About 90 per cent. of the total calories *per diem* may be drawn from this group; 30 per cent. fat and 60 per cent. carbohydrate making a reasonable distribution between the two members.

In the supplemental group of foods may be included those which are of value because of inorganic or indigestible constituents and the various condiments that stimulate the appetite and promote digestion.

In estimating the amount of food required daily by an individual, the greatest precision is attained by employing measurements in terms of calories. Bearing in mind that the fuel elements in the food are the source of energy, whether this appears primarily as heat or is first manifested in muscular activity, it is obvious that the needs of the body will be governed by a number of circumstances and that it is not possible to fix upon invariable figures expressing the needful number of calories for each day. Exposure to cold, particularly when the heat-absorbing capacity of the surrounding air is augmented by humidity, is an important factor raising the demand for fuel. The intensity and duration of manual labor is the other chief factor which is subject to wide variations.

The minimal need of an adult in complete repose and well protected by warm covering in bed is from 1500 to 1700 calories. Sedentary occupations with moderate exercise raise the amount to about 2500 calories, and heavy manual labor increases the total to from 3000 to 4000 calories. The average need for farmers is placed at 3500, and this is a fair allowance for mechanics not engaged in unusually continuous and severe muscular effort, such as blacksmithing, wood-sawing, etc.

As a rule, women require about 10 per cent. less fuel than men, but this is probably due to differences in size and occupation between the sexes. The loss of heat is proportional to the superficial area of the body, large people requiring more fuel to maintain a normal temperature than small people.[1]

A newborn infant, weighing 8 pounds, requires approximately 370 calories per day; a child of ten years about 1500. School boys participating in winter sports while lightly clad and therefore exposed to cold during periods of great muscular activity require almost 5000 calories, an amount demanded by few occupations in adult life, and the appetite of the school boy is correspondingly phenomenal.

On the basis of 2500 calories per day, these might be distributed among the foodstuffs as follows:

10 per cent. protein	250 calories,	approximately	62 grams	(2.2 oz.)
30 per cent. fat	750	"	"	82	"	(2.9 oz.)
60 per cent. carbohydrates	1500	"	"	375	"	(13.3 oz.)
100 per cent.	2500				

[1] The area of the body may be calculated with reasonable accuracy from the weight and height of the individual by Meeh's formula: $A = \sqrt{w} \times \sqrt{h} \times 167.2$ in which A = area in square meters, w = weight in kilograms and h = height in centimeters.

These figures cannot be applied directly to the selection of natural foods, since very few of these belong exclusively to one class of foodstuff. Meats contain not only protein, but also varying quantities of fat. And most carbohydrates and animal fats contain protein. In calculations concerning a dietary, these complexities in the composition of natural foods should be considered. Examples of such calculations applied to recipes and meals are given below. For infant feeding these conceptions have been familiarized in the formulæ for the modification of cow's milk. Similar methods may be made applicable to the more varied dishes of any menu.

Another obstacle lies in the fact that a third measure of quantity, the calory, is introduced into the calculations. Few people have habituated themselves to estimate amounts of food in terms of calories although this is the most direct and convenient way of making the provision of food conform to the needs of the body.

The sources of information that would encourage thought in this direction have not until recently been brought to popular attention in tangible form. The prices of food products in this country have generally been on a comparatively low level and the need of economy has not been urgent. But since the beginning of the war patriotic motives and the necessity for saving have made such economies a matter of importance. The public press has contained many articles on food values and market prices and called attention to ways in which saving could be effected and a few restaurants have placed upon the bills of fare the estimated calorific values of the portions served.

This is such an important educational movement that a brief abstract of such a menu is given. The figures in parenthesis indicate the calorific value of an average portion:

		Cents.
(170–250)	Toast, dry or buttered	10
(289)	Milk toast	20
(18)	Coffee	05
(60)	Coffee with cream	10
(195)	Milk per glass	10
(18)	Tea, per pot	10
(150)	Hot chocolate	10
(270)	Rice with butter	10
(300)	Rice with milk	15
(300)	Crackers with milk	15
(250)	Flaked cereals with milk	15
(216)	Shredded wheat with milk	15
(140)	Minced ham sandwich	10
(130)	Ham sandwich	10
(140)	Oyster sandwich	10
(200)	Fried egg sandwich	15
(180)	Sliced chicken sandwich	20
(430)	Club sandwich	50
(460)	Corned beef hash	25
(600)	Broiled lamb chop	30
(340)	Plain omelet	30
(390)	Onion omelet	35
(530)	Ham omelet	35
(470)	Hamburger steak	40
(600)	Fried or broiled ham	40
(720)	Broiled bacon	40
(680)	Bacon and eggs	50

		Cents.
(650)	Ham and eggs	50
(250)	Potatoes	10
(220)	Carrots	10
(90)	Turnips	10
(65)	String beans	10
(160)	Onions	10
(30)	Cabbage	10
(65)	Beets	10
(200)	Vegetable soup	10
(210)	Chicken soup with rice	15
(315)	Baked spaghetti with cheese	15
(460)	Baked beans	15
(456)	Baked beans with pork	20
(450)	Beef stew with vegetables	30
(524)	Sausage with potatoes	35
(515)	Cold ham, potato salad	35
(292)	Wheat Cakes with Syrup	15
(375)	Cornmeal Cakes with Syrup	15
(140)	Stewed apricots	10
(150)	Cruller	05
(90)	Fresh apple sauce	10
(270)	Layer cake	10
(150)	Stewed prunes	10
(265)	Creamed tapioca pudding	10
(340)	Pie	10
(220)	Cup custard	15

The prices are those of February 3, 1919.

The single calory is too small an amount to be useful in appraising fuel values for domestic purposes. It is, however, an interesting coincidence that so many familiar articles of food are equivalent to 100 calories. One ounce of most cereals closely approximates this value, so does a shredded wheat biscuit the average weight of which is a trifle under one ounce. A yellow banana, somewhat above the average size, a large apple or orange, a Bermuda onion, a potato about the size of a woman's fist, all have values not far from 100 calories.

The accompanying photographs in which amounts of uncooked food equivalent to 100 calories are compared with the capacity of an ordinary tumbler or the size of a Swedish match-box or butter-plate will help to fix in mind this 100 calory quantity.

Food Economics.—There are difficulties to be overcome in putting methods of this sort into practice. Among these difficulties is the translation of measures by volume into their equivalents in weight. The available scientific data concerning food values are expressed in terms of weight, the metric system being most usually employed. The recipes for domestic dishes are most frequently given in terms of ill-defined measures of volume, such as the "cup, tablespoon," etc. This implies a latitude in the use of recipes allowing for the exercise of the taste and skill which constitute the Culinary Art. But such domestic habits offer obstacles to the precise application of scientific methods to household economics and have a tendency to discourage such attempts.

A certain amount of arithmetical calculation is unavoidable in making a practical application of fuel values to household economics because the market prices of food supplies vary with the season of the

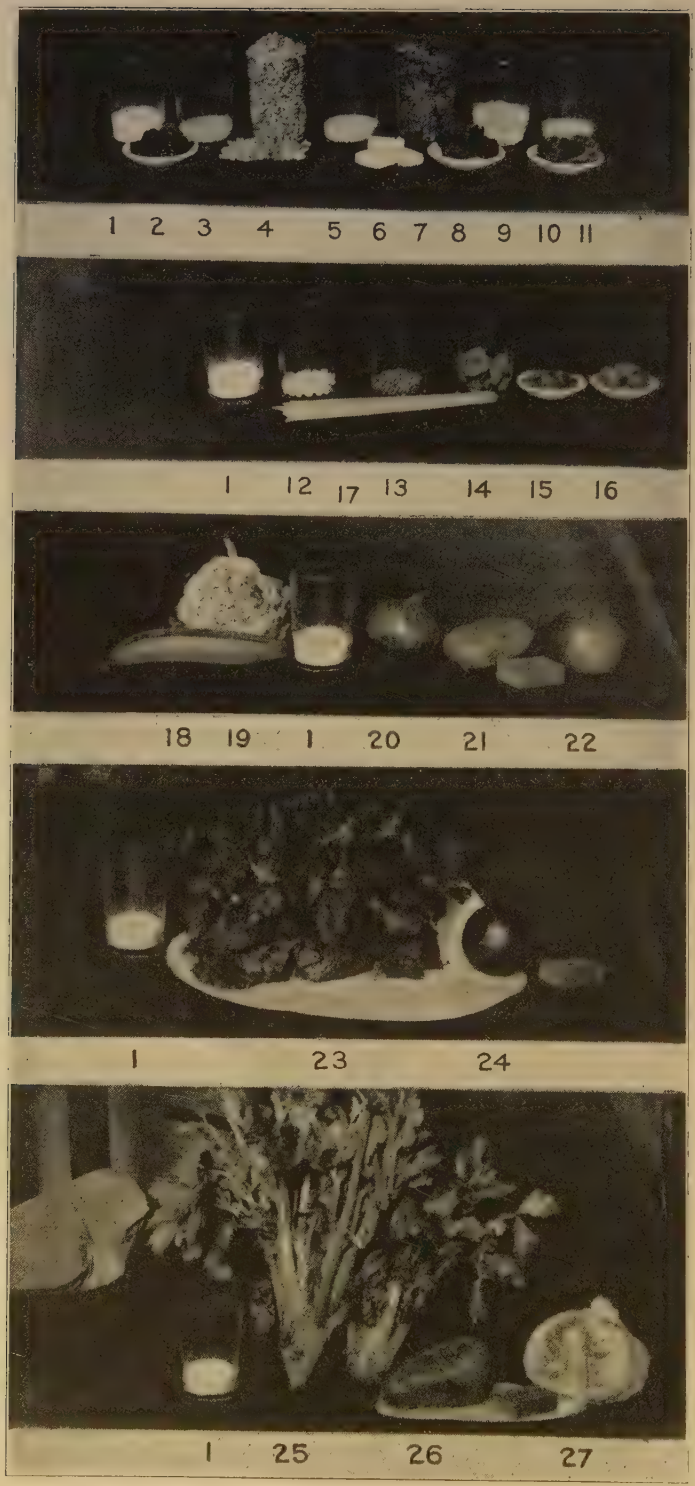

FIG. 43.—Photographs of one hundred calory portions.

year and local conditions. The recipes used in preparing dishes are almost legion and are modified according to the taste and skill of those in the kitchen as well as the desires in the home and for this reason a standardization of recipes for household use would be impracticable.

To render the application of arithmetic to this economic problem as simple as possible, the following table has been prepared as an example of the way in which certain basic calculations can be made once for all, yielding factors for use with the market prices prevailing at the time.

In this table the average weight of a "cup" is given in grams, following this is the fuel value of that amount expressed in calories. The next two columns give the cost-factors of a "cup" and a portion of 100 calories, respectively. By multiplying the price per pound of the commodity by the appropriate factor, the cost of a "cup" or of a portion (100 calories) can be calculated.

With the aid of an extended table of this sort, it is possible to estimate the cost in materials of a recipe and its fuel value. The economy that could be effected by substituting, for example, one cereal for another or oil for butter can also be ascertained by comparing the costs per 100 calories; thus discovering a means of maintaining the fuel value while reducing the total expense.[1]

Eggs have not been included in the table because they are not usually sold by weight. The fuel value of the average egg may be taken at 74 calories; the white at 16 and the yolk at 58 calories, respectively.

Multiply cost per pound by "cup cost-factor" to get cost per cup.

Multiply cost per pound by "100-calory cost-factor" to get cost of 100 calories.

For example, if rice costs 6 cents per pound, 1 cup costs 2.64 cents and 100 calories cost 0.384 cents; whereas corn flakes at 15 cents, per pound, cost but 1.59 cents per cup though 100 calories cost 0.93 cents, or nearly 2.5 the cost of the rice in equal fuel amount.

[1] The figures in this table are arrived at in the following manner: The weight of a "cup" of the article being found by actual weighing, the calorific value can be calculated from the analysis (consult data in Government Reports or in "Food Products," by Henry C. Sherman, The Macmillan Co.) The cost-factor per "cup" is obtained by dividing the number of grams in a "cup" by 453 (the number of grams in a pound); the 100-calory cost-factor by dividing the number of grams in a 100-calory portion by 453.

DESCRIPTION OF FIG. 43.

1, flour, 28 gm. (1 oz.); *2*, raisins (seeded), 29 gm. (1.02 oz.); *3*, head rice, 29 gm. (1.02 oz.); *4*, puffed rice, 29 gm. (1 oz.); *5*, hominy, 28 gm. (1 oz.); *6*, sugar, 25 gm. (0.88 oz.); *7*, corn flakes, 28 gm. (1 oz.); *8*, prunes (four), 39 gm. (1.37 oz.); *9*, rolled oats, 25 gm. (0.88 oz.); *10*, figs (two), 32 gm. (1.12 oz.); *11*, pearl barley, 28 gm. (1 oz.); *12*, beans, 29 gm. (1.02 oz.); *13*, lentils, 29 gm. (1.02 oz.); *14*, almonds, 28 gm. (1 oz.); *15*, almonds, shelled, 15 gm. (0.54 oz.); *16*, filberts (three), 30 gm. (1.05 oz.); *17*, macaroni, 28 gm. (1 oz.); *18*, banana, 156 gm. (5.52 oz.); *19*, cauliflower, 328 gm. (11.57 oz.); *20*, onion, 228 gm. (8.03 oz.); *21*, potato, 150 gm. (5.27 oz.); *22*, apple, 212 gm. (7.49 oz.); *23*, spinach, 418 gm. (14.76 oz.); *24*, orange, 268 gm. (9.45 oz.); *25*, celery, 671 gm.(23.67 oz.); *26*, carrot, 286 gm. (10.08 oz.); *27*, cabbage, 376 gm. (13.26 oz.).

	Cup, grams.	Cup, calories.	Cup Cost-factor.	100 calories, Cost-factor.
Rolled oats	70	290	0.154	0.055
Scotch oats	161	653	0.352	0.055
Corn meal	180	640	0.396	0.062
Corn flakes	48	178	0.106	0.062
Hominy	162	588	0.353	0.062
Cracked wheat	175	657	0.385	0.062
Cream of wheat	175	657	0.385	0.062
Farina	180	669	0.395	0.062
Pettijohn	77	280	0.170	0.062
Grape nuts	160	575	0.351	0.059
Barley (pearl)	200	732	0.440	0.062
Rice (head)	200	723	0.440	0.064
Tapioca	180	653	0.395	0.062
Macaroni	100	364	0.221	0.062
Flour	114	408	0.254	0.062
Bread crumbs	80	247	0.176	0.056
Sugar, granulated	200	820	0.440	0.055
powdered	160	656	0.350	0.055
brown	150	585	0.330	0.057
Molasses	320	943	0.705	0.077
Milk	244	175	0.540	0.320
condensed	270	870	0.600	0.068
Cheese, grated	100	456	0.221	0.044
	20[1]	91[1]	0.044	0.044
Butter	180	1116	0.400	0.028
Butter	12[1]	93[1]	0.026	0.028
Salad oil	180	1740	0.400	0.024
	12[1]	116[1]	0.026	0.024
Peanuts, shelled	140	790	0.310	0.040
Beans, dried	200	706	0.440	0.064
Peas, dried	200	728	0.440	0.062
Lima beans, dry	200	712	0.440	0.064
Lentils	200	715	0.440	0.064
Prunes	180	475	0.395	0.086
Dates	180	576	0.395	0.064
Raisins, seeded	160	563	0.350	0.064

As an example of calculation to ascertain the calorific value of a recipe and the cost, together with the economy effected by substituting cheaper ingredients, the following recipe for gingerbread may be chosen:

⅓ cup butter	372 calories at 40 cents per pound	5.33
1 cup molasses	943 calories at 4 cents per pound	2.82
1 egg	74 calories at 48 cents per dozen	4.00
2¾ cups flour	1122 calories at 4 cents per pound	2.80
1½ teaspoonfuls soda ½ teaspoonful salt 1 teaspoonful cinnamon 1 teaspoonful ginger ¼ teaspoonful clove ⅔ cup boiling water		0.50
	2511 calories at a cost of	15.45 cents

[1] Tablespoon.

COST OF 100 CALORIES, 0.615 CENT.

Same recipe, using substitutes:

½ cup peanut oil (salad) . .	580 calories at 22 cents per pound	2.93
1 cup molasses	943 calories at 4 cents per pound	2.82
¾ cup milk	132 calories at 5 cents per pint	2.10
2¾ cups flour	1122 calories at 4 cents per pound	2.80
Spices and soda as above		0.50
No water required (milk)		
	2777	11.15 cents

Cost per 100 calories, 0.402 cents.
Saving of ⅓ cost in fuel value (35 per cent.).
Saving of ¼ cost of loaf (27 per cent.).

Food Selection and Preparation.—In the preceding paragraphs, the fuel value of foods has been the chief consideration. It is quite evident that this is merely one of the fundamental considerations. The quality of the individual articles making a part of the dietary and the way in which the articles are prepared for consumption are also of paramount importance. Food to be utilized must be digestible and assimilable and, to obtain full benefit, the dishes forming a meal should be appetizing. In this country there are two very common delinquencies in this respect. One of these is the failure to sufficiently cook cereals or bake bread, cake or pastry. These latter should not be doughly when chewed, but break up and readily mix with the saliva during mastication. The other common error is in seasoning. Cereals, to take these as an example, are frequently rendered palatable only when overloaded with sugar, through a failure to appreciate that a proper amount of salt will develop the natural and delicate flavor peculiar to each variety of grain. Masking this flavor with sugar reduces all cereals to a very nearly common level and limits the pleasures of change. In preparing meat for the table, particularly stews which are relatively economical, the advantages of slow, prolonged cooking is frequently overlooked. The changes which make the meat digestible are not readily brought about in a brief time. Simmering for a considerable period is better than rapid boiling of brief duration. The meat is rendered more tender and the flavor is conserved. When coal is used for cooking, this can be accomplished on the back of the stove. If gas is employed, a properly constructed fireless cooker can be used to maintain an adequate temperature to complete cooking after the initial heat has been attained (real boiling until all is heated through) on the range. This applies not only to stews, but to cereals, which can be started in the evening and should be warm enough without reheating for breakfast.

When substitutions are made in an acceptable recipe, neither the flavor nor the essential quality of the constituents should be appreciably altered. If the original recipe calls for protein constituents of a certain class, proteins of the same class should be contained in the substituted recipe, or should be supplied by some further addition. Milk, for example, may be used for eggs insofar as the proteins are

concerned, but if the texture of the product in the original is dependent upon beaten eggs for its lightness, this texture must be attained in other ways, *e. g.*, by the use of baking powder, to avoid disappointment in the result. It is in these directions that the skill and ingenuity of the experienced cook have ample opportunity for display. In the selection of protein constituents of a recipe, regard must also be paid to the differences in quality, the presence of vitamines, etc., that characterize proteins from various sources. It should also be recalled that fats are not all equivalent, butter, for example, containing constituents in small amount not present in highly refined vegetable oils. But many of these deficiencies can be made good in ways not precluding the economies attainable by relatively cheap substitutes.

The important role played by fruit and vegetables in a dietary should not be overlooked. Either fruit or vegetables should form a part of every meal but the simplest. One reason is that most vegetables and some fruits contribute indigestible cellulose (vegetable fiber) which gives bulk to the meal, thereby promoting the penetration of digestive secretions and the propulsion of the mass along the digestive tract. By attention to this matter, habitual constipation can often be avoided. This value of vegetables and fruit is a mechanical one.

But fruit and vegetables also have a somewhat more subtle chemical value which deserves attention. They contain salts of the fixed alkalies which on combustion in the body yield carbonates rendering the ash basic. They constitute the chief source of these alkalies. The proteins, except milk, and carbohydrates, with the exception of the potato, which may also be classed as a vegetable, and sugar leave an acid ash when burned. The natural fluids of the body are neutral or faintly alkaline according to the criterion employed and this reaction is jealously guarded by physiological means during health and appears to be of importance for the normal processes of life.

While the pathology of chronic rheumatic disorders is intricate, there is probably a connection between these troubles and an inappropriate diet. Within this domain the suitable balancing of acids and bases probably plays some part, and an intelligent dietary will include such considerations. To maintain health, it appears desirable that the residues of combustion, the ash of the food, should not be too preponderatingly acid.

It is interesting in this connection to note that many of the combinations that are generally acceptable in daily life offer illustrations of a tendency to balance acid and basic constituents. Thus pork (acid) and beans (basic) or apple sauce (basic), corned beef and cabbage, rice and raisins, cheese with salads (basic because the vegetable acids are consumed and carbonates formed), mutton or game and jellies, bread and cheese (both acid) with lettuce, fruit or onion, steak smothered in onions. Examples occur on every hand, as though the experience of the race was emphatic in recognizing the importance of avoiding an excess of acid residue following the consumption of any meal.

In further illustration, the following analysis of light breakfasts is given:

BREAKFASTS.

	Weight, grams.	Calories. Protein.	Fat.	Carbohydrates.	Total.	Ash.[1] Acid.	Basic.
Coffee:							
Milk	145.0	19.0	51.62	29.38	100.0	....	2.6
Sugar	12.5	....	.....	50.0	50.0		
Roll	36.0	13.0	8.0	79.0	100.0		
Butter	13.0	0.5	99.5	.....	100.0		
		32.5	159.12	158.38	350.0	0.0	2.6
Oatmeal	25.0	16.1	15.0	68.9	100.0	3.0	
Cream, 18 per cent.	51.0	5.1	81.7	13.2	100.0		
		53.7	255.82	240.48	550.0	3.0	2.6
Egg	56.0	26.0	48.0	.....	74.0	7.0	
Toast, 1 piece	.....	6.5	4.0	39.5	50.0		
Bacon	17.0	6.7	93.3	.....	100.0	0.8	
		92.9	401.12	279.98	774.0	10.8	2.6
Orange	268.0	2.6	2.7	91.1	100.0	....	11.0
		95.5	403.82	371.08	874.0	10.8	13.6
Apple, fresh	212.0	2.6	5.66	91.74	100.0	....	6.0
Peach, fresh	297.0	6.8	2.64	90.56	100.0	....	12.2
Prunes (dry)	39.0	2.8	.....	97.2	100.0	....	8.0
Figs (dry)	32.0	5.4	8.54	86.06	100.0	....	32.3
Dates (dry)	32.0	2.4	7.12	90.48	100.0	....	3.2

The very simple breakfast of 350 calories yields a basic ash due to the milk in the coffee. The addition of oatmeal and cream makes a nearly neutral combined ash. But when the diet becomes more distinctly protein by including egg and bacon, the residue becomes decidedly acid. This may be corrected with an orange or some other fruit. All this is quite in harmony with the varying customs. If fish or meat are taken at breakfast, potato usually accompanies the more hearty protein meal, and the neutrality of the ash is thus secured.

In the preceding pages normal conditions have been the subject of consideration. The results of departures from such normal conditions also claim attention.

Beyond the question of calories, food may affect health in a variety of ways.

Excessive Amounts.—As already indicated, the quantity of food required to maintain the body in health varies with the climate and season, clothing, occupation, work, etc., of the individual. The tendency in this and other civilized countries is to eat excessive amounts of food. The art of cooking has produced so many appetizing dishes that more food is consumed than is necessary for the maintenance of the best bodily health. Overeating results in overloading the digestive organs; the stomach and intestines become enlarged; the liver engorged; and conditions ensue leading to degenerative changes.

[1] The unit in which the acid or basic value of the ash is expressed is 1 c.c. of a normal solution of an acid or alkali. If sodium hydrate be the base chosen, this amounts to 40 mg., the equivalent of 84 mg. of sodium bicarbonate. The basic value of 100 calories of milk is therefore equal to 0.2184 gm. of sodium bicarbonate, or 3.37 gr. One hundred calories of figs is equivalent to over 2.7 gm. of sodium bicarbonate, or 41.5 gr. For further information on this subject, see "Food Products," by H. C. Sherman, from which the above data are taken.

These, when chronic, tend to produce such diseases or so-called "diatheses" as obesity, gout, rheumatic affections, fatty heart, lithemia, oxyuria or the formation of calculi (renal, vesical or hepatic). Congestion of the liver and the condition known as "biliousness," with coated tongue, concentrated urine, constipation, headache, etc., are almost certain to be the result.

Insufficient Diet.—Lack of sufficient food for the maintenance of the body is starvation, while a failure to assimilate food is inanition. In the majority of cases, six to ten days is the limit of life with complete starvation, though professional fasters claim to have lived forty days without anything but water. Appetite or hunger is not always the best guide to the need of the body for food.

Famine and pestilence are often mentioned together in describing great epidemics occurring on a large scale, such as those of plague, small-pox, typhus fever, and other pestilential diseases, which are called famine fevers. But there is no definite relationship so far as we know, between famine and epidemics.

Unbalanced Diets.—The lack of variety or monotony in the food, or the insufficiency or excess of certain elementary food substances in the diet, known as unbalanced diets, may seriously affect health. Thus anemia may be produced from lack of meat or other food; scurvy from lack of fresh fruits and vegetables, with excess of salt food; rickets and marasmus from an excess of starchy food and lack of animal food, mineral salts, etc., a form of acidosis in babies from too much fat; acne or eczema from too much carbohydrate; constipation from too concentrated diet and too little water between meals; and gout, and possibly rheumatism, from faults of various kinds in the diet. Many other disorders are attributed to unbalanced diets, as beri-beri, for instance, a disease occurring chiefly in those countries where polished rice is the main or monotonous article of diet; and pellagra, an affection formerly thought to be due to the eating of spoiled corn, but now believed to be caused by a faulty diet, consisting largely of maize or Indian corn and a deficiency of proteins.

The need of a mixed diet is emphasized in certain "dietary diseases" resulting from a one-sided diet. Failure of growth and causation of certain diseases have occurred with diets which chemical analysis showed contained the requisite foodstuffs—protein, sugars, starches, fats, etc., and it became evident that there are other indispensable elements of our food which as yet cannot be definitely ascertained by the usual methods of chemical analysis. These constituents are termed "*vitamins.*" Valuable experimental researches have been made by F. E. Hopkins (1906), Shepp (1909), Fraser and Stanton (1907), and Casimir and Funk (1911), which strongly suggest the presence of an essential unidentified principal in diets as necessary for growth and the maintenance of physiologic well-being as the known food constituents. Although direct evidence is available only in the case of beri-beri, Funk assumed the existence of a specific vitamine in the case of scurvy, pellagra and rickets. This assumption, however, is denied by McCullom and others who claim that scurvy, pellagra and

rickets are due, not to lack of a specific vitamine, but to lack of other dietary essentials or to bacterial or other causes. (See chapter on Vitamins.)

Salts in the Diet.—Certain salts, when derived from fresh vegetables and fruits, are also indispensable articles of food. These salts are formed by the common organic acids, such as citric, tartaric, malic, etc., in combination with the bases, calcium, sodium, potassium, etc. When absorbed they form carbonates in the body and aid in maintaining the alkalinity of the blood. It is to the lack of sufficient potash salts, especially potassium carbonate, that scurvy is thought to be partly due, and this condition is intensified by an excess of salt in the diet. Deficiency of calcium phosphate in the food of infants and growing children leads largely to rickets. As the result of poor development, due to lack of this salt, the bones become soft and bend under the strain of the body weight. Again, an insufficiency of inorganic salts in the food impoverishes the hemoglobin of the red blood corpuscles, upon which depends their oxygen carrying power, and thus tends to the production of anemia and other disorders.

Meat Inspection.—The sanitary control of food is necessary for the protection of the consumer. This is especially true of the animal foods such as meat and milk which are the most likely to become infected or decomposed. Meat inspection is important not only on account of the long distances over which it has often to be transported to market, when there may be danger of eating it in an infected or diseased condition, but the mere handling of flesh of some animals may suffice to convey infection to those who touch it, with anthrax or glanders. Diseases among cattle, sheep and swine, such as rinderpest, foot-and-mouth disease, Texas fever, etc., may also be detected and prevented by systematic meat inspection.

The Federal Meat Inspection Law, which is administered by the Bureau of Animal Industry under the direction of the Secretary of Agriculture, provides for the inspection of cattle, sheep, goats and swine, the meats or meat-food-products, which are to enter into interstate or export trade. This law does not apply to meats butchered, dressed and sold within the State, though much of the meat slaughtered, shipped, sold and consumed wholly within a single State comes under Federal inspection. Many States, moreover, have passed laws similar to the Federal law to protect their own citizens, so that there is a more or less uniform method of meat inspection throughout the country. The Federal law provides for the inspection of the slaughter houses, the packing houses, the meat canning, salting, rendering or similar establishments; for the inspection of animals before and after they are slaughtered and for the condemnation and distinction of diseased carcasses or parts of carcasses. The sanitary conditions of the establishments and the health of the employes are also under the control of this law. Carcasses or parts of carcasses with the following diseases or conditions are condemned, depending on circumstances: Anthrax, pyemia and septicemia, vaccinia, rabies, tetanus, malignant epizoötic catarrh, hay cholera and swine plague, actinomycosis, caseous lymph-

adenitis, tuberculosis, Texas fever, parasitic icterus, hematuria, mange or scab, trichinosis, tapeworm, infections that may arise from meat poisoning, etc.

The Changes in Food Wrought by Cooking.—Within a household the hygiene of the table centers on the range.

"Cooking," says Rosenau, "may be regarded as the greatest sanitary innovation ever introduced by man to protect himself against infection." Metchnikoff dwells upon the great sanitary value of cooking. In the animal as well as in the vegetable world some natural foods are ready for digestion, as milk, raw eggs too, are perfectly digestible and are often given to invalids. "Raw meat cures" have also been proclaimed, and it has been found that tender and juicy raw meat, if chopped very fine to break the connective tissue, is well digested. But raw meat does not seem palatable to most of us, while cooking, especially broiling, brings out its flavor and makes it more acceptable to the taste, a by no means unimportant factor in good digestion. Moreover, the heat required for cooking kills all forms of infection and thus renders food safe, so far as these dangers are concerned. The heat also destroys most of the toxic products of decay; though some foods may contain heat-resisting poisons such as muscarin, the poisonous principle in certain toadstools, and a poison sometimes found in mussels. But foods do not ordinarily contain heat-resisting poisons resulting from bacterial decomposition.

Food thoroughly cooked throughout reaches a temperature of 140° F. (60° C.), at which degree of heat non-sporebearing bacteria are for the most part destroyed. But much meat and many vegetable foods are preferred rare or underdone, and in such cases the outside of a large joint of meat, for instance, may be thoroughly cooked or even dressed, while the inside may be practically raw or not sufficiently cooked to destroy any parasites present.

One of the objects of cooking is to soften the connective tissue, thereby turning it into a sort of gelatin, and by loosening the muscle fibers of meat and coagulating the albumen, to render it more savory and tender, and thus to make it more digestible. But unfortunately, unless the meat is very tender from the start, this requires a longer application of heat than is needed to cook the delicate albumen all full of flavors too easily lost. To soften the connective tissue without overcooking the albumen, and yet to cook it sufficiently to bring out these flavors, constitutes one of the problems of meat cooking. Tough meats may be pounded to separate the connective tissue bundles, or may be chopped or minced, or they may be steeped for several hours in fresh or sour milk or in vinegar. Cooking breaks open and softens the cellulose and fibers of vegetables, causes the starch grains to swell and burst, and converts the insoluble starch into dextrine or soluble starch.

Exposure to steam at 158° F., for a long time has the same effect as cooking foods thoroughly, and this possesses the advantage of retaining the juices, and preventing burning or the results of overheating. Moreover, the process requires little or no attention. The

so-called "fireless cookers" now on the market in various forms are a modification of this method. These consist simply of an insulated box, in which the food after heating is placed in suitable vessels, and kept at a temperature of over 158° F. (70° C.) for several hours.

As to the choice of cooking utensils, it may be said that the use of brass and copper are not advisable, because of the *verdigris* or green rust, the poisonous acetate of copper, which is apt to form on them, unless kept scrupulously clean. Acid foods should not be cooked in copper pots, nor should milk or substances containing sugar be kept in such vessels, because of the possible extraction of copper by these acids. Of metal ware, tin, nickel, and aluminium are the best. Enameled iron is satisfactory, provided it does not contain lead or become chipped.

Methods of Cooking.—Herein lies the fine art of cooking. Simply stated, the methods in general use are: (1) roasting; (2) broiling; (3) boiling; (4) frying; (5) stewing.

Roasting and broiling involve practically the same principle, as also does baking, the cooking being done by the medium of heated air. The dry heat of the coals affects the outer layer of the meat, as does the hot air of the oven. There is a considerable shrinkage, due mainly to the loss of water. The heat coagulates the exterior of the meat and then prevents the further loss of juices and drying up. It is necessary to baste the meat by pouring water or melted hot fat over it from time to time, in order to obtain sufficient heating of the meat throughout a large joint without the danger of burning it.

In boiling the meat is placed in boiling hot water, if it is desired to maintain the flavors within the mass, the albumen being thus coagulated at once at the surface. If a rich broth or soup, on the contrary, is desired the meat must be placed in cold water and gradually heated, the soluble albumens in this way being allowed to pass out into the water.

Frying or so-called "dry frying," consists in placing the meat or other food into boiling hot fat, lard, or vegetable oil, which causes a rapid coagulation of the albumen on the surface and a retention of the flavors and juices, as in the first mentioned process of boiling. If the fat is not boiling hot it will penetrate the tissues and cause the meat or other food to become greasy. For this reason fried substances are apt to be indigestible.

In stewing the meat is cut into pieces and placed in cold water, which is gradually heated to about 180° F. (84° C.), at which temperature it is kept for several hours. If heated too much, the meat becomes tough and stringy.

The choice of methods of cooking depends largely on the quality of the meat to be cooked. Trimmings and tough portions may be made into soup. Rather better pieces, but still requiring long cooking to soften the connective tissue, may be made into a stew or ragout, or if the piece is large and compact, boiled in water; but meat that is tender and juicy should be boiled, roasted or broiled, choosing oftenest the last two methods, because of the more perfect retention of the juices and flavors.

CHAPTER X.

VITAMINES.

By ALFRED F. HESS, M.D.

Until recently foods were valued largely in proportion to their caloric content; thus the potato was regarded as a highly nutritious food, whereas the tomato was looked upon as possessing almost no food value whatsoever. Recent investigations, however, have caused us to modify and enlarge our views in this regard. It has come to be realized that in addition to the proteids, carbohydrates and fats, with an appropriate amount of salts and water, there are other less clearly defined substances which are of essential importance for nutrition and especially for growth. These newly discovered substances have been termed "vitamines" (Funk), "accessory food factors," "food hormones," by various physiologists, or have been designated according to their solubility as "fat soluble" or "water soluble." Their designation is of minor importance, more particularly as none has been isolated in a pure state, and therefore correct chemical terminology is at the present time impossible; nor is their mode of action understood. It has been suggested frequently that they are not utilized directly by the body, but that they function as catalyzers. This conception emanates from the fact that they are required in minimal amounts in order to supply the body needs, and because this action is so striking in its rapidity. Another view which is attractive, but which also has no experimental basis, is that they act as hormones in connection with the functions of the glands of internal secretion.

At present it may be stated that there are three distinguishable vitamins. The first discovered was the vitamine reported by Hopkins as essential to the growth of rats, and later associated with beriberi in man and polyneuritis in fowl. A second is the fat-soluble vitamine described by McCollum and by Osborne and Mendel, and a third is the vitamine studied by Theobald Smith, by Holst and others, and which is essential to the prevention of scurvy. It is probable that there are still more of these interesting substances which are essential to our welfare, and that their discovery will lead to the recognition of further nutritional disorders. The lack of any of these three dietary factors leads to a definite disturbance which has been termed "a deficiency disease." This term is open to the criticism that it is by no means certain that a deficiency is the sole cause of the disorder, for a secondary toxic factor may well play a role. In addition to the disorders definitely occasioned by the lack of these vitamines, there are others which have been included in this group with more or less validity,

such as rickets, pellagra, osteomalacia, war edema, the "mehlnaerschadung of Czerny," and various indefinite diseases involving the nervous system. It will be well to consider merely the three "vitamines" which have been identified biologically, and to review briefly the symptoms which develop when they are supplied in insufficient quantity to animals and to man.

The experimental basis of our knowledge of the water-soluble vitamine was, as mentioned above, largely the result of the work of Hopkins, who found that animals could not live and grow on a diet of purified food substances, but that the addition of a very small quantity of a natural food, such as milk, was sufficient to render the dietary complete. Later it was shown that absence of this vitamine is the essential factor in beri-beri, a disease of the nervous system prevalent in the Far East. This disease is brought about when the diet consists largely of polished rice, and is promptly cured by substituting the unpolished rice for the white variety. As shown by Eijkman, a similar disease can be reproduced in fowl by means of a diet of polished rice and cured by the addition of the pericarp or an alcoholic extract of this substance. This vitamine is widely distributed among the foodstuffs; it is present in most concentrated form in yeast, and is to be found in all seeds and eggs. In the seeds it resides in the aleurone layer and particularly in the germ or embryo, but is completely absent in the endosperm. It is also present in other seeds, such as peas and beans, and in the various leafy vegetables, such as cabbage and spinach, which are used extensively for human food. Milk and eggs contain it in less degree, and starch, sugars, refined flours, fats and oils are practically devoid of the "antineuritic vitamin." It is evident that a people living on a varied diet will obtain a sufficient amount of this essential substance. If the dietary is greatly restricted, however, if it consist mainly of polished rice or finely bolted flour, beri-beri will gradually develop. This disease has been prevalent for many years in the Philippines, in certain parts of China and India, in the Dutch Indies and the Malay States, owing to the prejudice of the natives against brown rice. However, since the mode of prevention has become recognized it has become much less frequent. In the Japanese navy, where previously it attacked thousands every year, it has been almost eliminated by simple dietary measures. Sporadic outbreaks have occurred in the United States and in England, and it is probable that occasional cases develop from time to time which pass unrecognized.

In addition to the water-soluble vitamine the body requires a supply of fat-soluble vitamine. This substance is by no means so widely distributed in nature as the water-soluble vitamine. It is present in largest amount in milk and in eggs, and in considerable concentration in the glandular organs such as the liver and the kidney, and furthermore in the cells of the leafy vegetables, for example in spinach and cabbage. The seeds of wheat, rye, barley, oats, etc., contain also small amounts of this vitamine, but the finely bolted flours prepared from these seeds are devoid of fat-soluble vitamin, as are the vegetable fats

and oils. It is therefore quite possible that even a liberal diet may contain an insufficient quantity of this dietary essential. The symptoms and the pathological processes resulting from an inadequate supply of this vitamine have not yet been thoroughly investigated. It has been shown, however, that infants who have been fed for long periods on skimmed milk develop a form of eye disease (xerophthalmia) which yields promptly to the addition of cream or butter to the dietary. There are probably other nutritional changes, especially in infants, which are occasioned by a deficiency of this substance.

The third so-called "deficiency disease" is scurvy, which is generally referred to as adult scurvy or infantile scurvy (Barlow's Disease). Experimental studies of this disorder have been carried out on the guinea-pig, whereas investigations of the other vitamines have been made on the rat. This disorder results from deprivation of fresh food for several months, especially of fruits and of vegetables. It takes many months to bring about this "avitamine" disorder, so that there are necessarily many rudimentary or latent cases. In the days of the sailing vessel scurvy was associated with long ocean voyages, and occurred frequently among sailors who had to subsist mainly on a diet of hard-tack and salted meats. Today it is endemic in Russia, and occurs only sporadically throughout Europe and the United States and probably most parts of the world. During the late war a decided increase in its incidence was reported both among the military forces of the eastern front and the civilian population of England and Europe.

Barlow's Disease is almost never encountered among breast-fed infants but develops in those who are fed cow's milk which has been heated and subsequently kept. It is met with particularly in babies who, for a period of months, have been given a formula of boiled or pasteurized milk, to which a proprietary food has been added. Scurvy develops more rapidly if the amount of heated milk is insufficient. This vitamine is far more sensitive to heat than are the other two, especially when an alkali has been added to the food. All babies who are receiving heated milk should also be given an antiscorbutic. Unless this is provided, scurvy is apt to develop with symptoms of pallor, hemorrhage of the gums, painful swelling of the bones, and marked susceptibility to infection. One of the most popular antiscorbutics for this purpose is orange-juice. Recently Hess and Unger have suggested the use of a more economical antiscorbutic, namely, canned tomato, strained and given to the amount of one ounce daily. Prunes possess practically no value in this regard.

All fruits contain this vitamine to some degree, oranges and lemons possessing it to the largest extent. Of the vegetables, the cabbage, onion, tomato, swede, and potato are particularly rich in this essential food factor. Meat when raw contains it in sufficient amount to afford protection if large quantities are consumed. Owing to this fact the inhabitants in the polar regions rarely develop scurvy, and recent Arctic expeditions have remained free from this scourge. Grains and seeds are devoid of this vitamine; when they are sprouted,

however, they develop marked antiscorbutic potency. Advantage of this fact was taken in the World War by the English, who made use of germinated pulses to supply antiscorbutic food for the army where fresh vegetables could not be included in the ration. When vegetables are dehydrated they lose most of their antiscorbutic potency, that is to say, when the method is carried out according to the dehydrating processes now in vogue. It is quite possible, however, that these methods will be improved so that they will retain a large part of their vitamine content. Until this comes to pass, however, we must see to it that the dietary contains fresh vegetables or fresh fruit.

CHAPTER XI.

THE PRESERVATION AND ADULTERATION OF FOOD.

By J. P. ATKINSON, B.S.

PRESERVATION OF FOODS.

There has been no time in the history of man, as we know it, when it has not been found desirable and necessary to save food for various periods of time. The Arabs of the desert, the Indians on the great plains and the Esquimaux in the frozen north, as well as people in the great cities of the past, have been accustomed to use means of preserving their food. These methods consisted of the simple physical methods that are still in use by drying in the air and sun and freezing and the use of chemical substances not only natural and inherent in foods, such as the essential oils in spices and lactic acid found in milk by natural means, but those selected for the purpose such as salt and vinegar. At present we have improved these methods in some respects and have added to them some that are not as harmless to the consumer. Some of the latter, namely, salicylic acid and benzoic acid, are found in small quantities naturally, either alone or together, in a number of edible vegetable foods.

Traphagen and Burke determined salicylic acid in the following:

Currants	0.57	milligrams per kilo	fruit.
Cherries	0.40	" "	"
Plums	0.28	" "	"
Crabapples	0.24	" "	"
Grapes	0.32	" "	"

Benzoic acid was determined in whortleberries to be 0.6 to 0.8 gm. per liter. Raspberries and horseradish contained either salicylic acid or phenol, and apricots and peaches and strawberries contain salicylic acid in appreciable quantities, while currants contain both benzoic and salicylic acid, and cranberries are well known to contain a considerable amount of benzoic acid. It has also been noted by other chemists that boric acid is a natural constituent, in small quantities, in grape and other plants used as foods.

F. C. Cook and J. B. Wilson have shown experimentally that plants growing in a soil containing boron will absorb it in varying proportions, depending upon the plant, soil, moisture, quantity of and solubility of the boron compound.

Fluorine must likewise be a constituent of some of our foods, since it is an important constituent of the teeth. According to Dr. Long, $\frac{1}{2}$ ounce of salt is about as much as one can consume per day. Some

might stand 1 ounce per day for a while, but 2 ounces per day would sicken and kill, possibly, $\frac{1}{6}$ ounce is sufficient per day for body needs. Dr. Long also remarks that "the pure oils extracted from spices are active poisons in the real sense of the word."

Sulphurous acid is probably an intermediate product in the metabolism of cystin, the sulphur containing amino-acid, found in egg white, casein and serum globulin. There is reason to believe that formaldehyde is a natural product, found during alcoholic fermentation under certain conditions. Likewise many of our most prized vegetable foods contain compounds that, considered alone, would be immediately condemned as violent poisons. Oxalic acid in rhubarb and hydrocyanic acid in certain varieties of beans, cassava, and peach and plum kernels illustrate this fact.

Foods naturally containing these preservatives and poisons cannot be condemned, yet, to quote Folin, "Formaldehyde, salicylic acid, boric acid, borax, sulphurous acid and sulphites cannot be defended as ingredients of food. The human body does not produce them and has not developed any special mechanism for excreting them. There is no sound reason for their use. Negative harmful results do not mean that the human is not injured."

This statement refers to these preservatives when added to food by manufacturers or others interested in prolonging their usefulness for commercial purposes. If used for this purpose, preservatives may also be useful in hiding inferiority or in actually enabling the food dealer to sell food unfit for human consumption. The use of formaldehyde in destroying the odor of rotten eggs is a striking example of this practice. Merely because fruits and vegetables contain such compounds as salicylic acid, boric acid and fluorine and other substances known to be injurious, it cannot be reasoned that it is proper, from any point of view, to deliberately add these substances as preservatives to foods.

Rideal states that "a disinfectant kills organisms, including spores. An antiseptic prevents animal and vegetable substances from undergoing decomposition." Food preservatives that have been used include both disinfectants and antiseptics. No preservative is added to food in such proportions that it can be termed a disinfectant, and in most cases added chemical preservatives must be helped in their work by processing with heat if the food is to be kept more or less indefinitely. The relative value of a number of compounds used as food preservatives is given in a "table of antiseptic substances" by Miguel.

The relative values are as follows:

Hydrogen peroxide	1 to 20,000
Salicylic acid	1 to 1,000
Benzoic acid	1 to 909
Boric acid	1 to 143
Sodium salicylate	1 to 100
Sodium borate	1 to 14
Alcohol	1 to 10
Sodium chloride (salt)	1 to 6

In the same table appears the following:

Mercury iodide	1 to 40,000
Silver iodide	1 to 30,000
Mercury bichloride	1 to 14,000
Phenol (carbolic acid)	1 to 333

It will be noted that hydrogen peroxide is among the most powerful, while benzoic acid is nearly three times as efficient as phenol.

In criticising a food preservative several phases must be considered:

1. Is it harmless or deleterious to health?
2. Has it food value?
3. If it has no food value, can a preservative having food value be used just as satisfactorily?
4. Does the preservative allow improper food material to be used in the preparation of the food?

In applying these criteria to food preservatives many animal experiments have been made, and feeding experiments on humans, in addition to recorded observations that have not been systematically planned, through physicians' records.

Those perhaps causing the greatest interest are the studies of Harvey Wiley on his "poison squad" and those subsequently carried out by the Referee Board of Scientific Experts. The findings of these two bodies of investigators will be mentioned later in discussing the individual preservatives available for use.

Preservation of food depends upon the inhibition or death of fermentive and putrefactive organisms and the restraint of enzymic action in the tissues. For this purpose the following physical methods and chemical agents have been used:

Drying and Removal of Water.—

(*a*) In the sun and air.
(*b*) In chambers or tunnels by means of dry air.
(*c*) By partial or complete vacuum system.
(*d*) By heating.
(*e*) Salting.

Freezing and Cold Storage.—

(*a*) Heating.
(*b*) Pasteurization.
(*c*) Sterilization.

All of these methods, if applied to foods suitable for human consumption, are legitimate and practicable.

Chemical Agents.—Chemical agents may be divided into three groups:

(*a*) Those that are considered to be harmless to the consumer.

(*b*) Those that are known or considered to be injurious to the consumer.

(*c*) Those whose action on the consumer is still in doubt.

Under division (*a*) may be mentioned the following:

1. Cane sugar.
2. Salt.
3. Vinegar, dilute acetic acid.

4. Alcohol.
5. Benzoic acid and its sodium salt in minimum quantities.
6. Volatile matter in smoke.
7. Spices, oils and extracts.

Under division (*b*) may be mentioned:

1. Formaldehyde.
2. Salicylic acid and its sodium salts.
3. Boric acid and its salts.
4. Fluorides.
5. Pyroligneous acid (liquid smoke).
6. Formic acid and formates.

Under division (*c*) the following may be placed:

1. Nitrates in pickling fluids.
2. Peroxides.
3. Sulphites, sulphur dioxide, sulphurous acid.

Drying.—The preservation of foods by drying is one of the oldest methods as well as one of the most efficient in use. All varieties of foods are susceptible of drying. The original method as practised by the American Indian and hunters is still in use. It consists in cutting meat into strips and hanging them in the sun and wind. The method of sun and air drying has also been used largely for fruits. During the past few years drying methods on a large commercial scale have been developed. In general, it may be said that these depend upon the removal of water by regulated heat or by vacuum aided by heat. The process in the drying of vegetables and fruits is carried out in machines capable of holding large quantities of material and requiring from three to twenty-four hours for the process. The various machines differ in mechanical construction, but the general principles are the same.

All caloric food value remains unharmed by this process. The effect of drying on the vitamin value of foods, however, remains to be definitely determined. Preservation by salting and by alcohol owe their effectiveness in part to the removal of water, and in this sense may be classified under drying methods. If drying of fruits and vegetables is carefully carried out so that only about 8 to 10 per cent. water remains, the product will keep indefinitely in sealed containers, and when placed in water will again absorb it. Vegetables, such as carrots, onions, potatoes, beets, turnips and spinach, regain their original forms, and the coloring matter of such vegetables as carrots, spinach and parsley, together with their characteristic odors and flavors, will remain. Almost perfect desiccation can be produced by fractioning off the water content of a food by successive alcohol extractions. If care is used the cell will take up water again and expand, provided the desiccation has not been carried too far. Alcohol, however, extracts with the water the color, oils and aromatic compounds of the food.

Cold Storage and Refrigeration.—These terms are sometimes confused, but their difference is very important. Cold storage is a general term and includes refrigeration. The temperature for cold storage

varies, according to the food to be stored, from several degrees below freezing to several degrees above freezing. Refrigeration refers to freezing temperatures only.

The temperature employed depends upon the nature of the product to be held. Fish and meat may be frozen. Eggs are kept at about 31° F., since they freeze at 29° F., and would burst if allowed to freeze. Such substances as butter may be kept either below freezing or slightly above. Fruits are kept a few degrees above freezing.

Experience has shown that foods are well preserved by cold if kept at the lowest temperature that is not physically destructive. Injury is caused to cellular foods, such as fish, meat, poultry, eggs, vegetables and fruits, through freezing by the bursting of the tissue cells and the subsequent loss of juice upon thawing. Thawed meat, fish and poultry are also less resistant to the attacks of microörganisms by reason of the cell fracture. Even at low temperature, certain microorganisms can develop slowly and may have a deleterious effect. For this reason protein foods, that readily undergo putrefaction, must go into the freezer only in the best condition. Eggs and poultry are noteworthy examples of this need.

Many States have cold storage laws. These laws control the quality of the foods to be held, the length of time in storage, the prevention of the restoring of certain kinds of foods when once taken out of cold storage and other conditions aimed to protect the consumer.

Cold storage offers the means of collecting foods at times of abundance and holding them for distribution during periods of nonproduction. Physiological and chemical investigations have shown that cold storage is a safe and reliable method of food preservation. A greater variety of foods are made available and food costs are stabilized.

Practically all varieties of foods are preserved in cold storage; for example, meats, poultry and game, fish, eggs, vegetables, fruits, nuts, butter and oils, and are found to be in excellent condition after many months of storage. Refrigerated protein foods should be kept at the storage temperature until they reach the consumer. These include all varieties of meat, poultry and fish. Since, as already stated, freezing damages the tissues and putrefaction begins very quickly after thawing it is important that these particular food substances should not be put back into the freezer after once having been removed.

Heating.—Preservation by heating is one of the most important methods, if not the most important one of keeping foods from spoiling.

The first method of canning was published by a Frenchman, Appert, in 1810. It was taken up in England about the same time and was first applied in America in 1839 by Isaac Winslow. Since that time the industry has made tremendous advances in all its aspects. Until the work of Pasteur, published in 1862, the cause of putrefaction was not recognized, and even after the results of Pasteur's work was known it required the further work of Tyndall to complete it. Preservation

by means of heating falls into two classes: (1) Sterilization, by which all living organisms are killed, including spores, and (2) pasteurization, by which only vegetating forms are killed.

Sterilization or Canning.—This is brought about by placing the food material in cans, creating a vacuum, sealing and raising the temperature to the thermal-deathpoint of the bacteria peculiar to the substance being canned. In some cases the material is washed in boiling water (blanched) and heated before being placed in the can. This removes dirt and kills organisms on the surfaces. It also has the effect of swelling the food material, so that the subsequent swelling in the can during processing will be reduced. This method is applicable to many varieties of foods, such as meats, milk, fish, poultry, vegetables and fruits. When glass is used as a container usually some preservative must be added. For preserves in glass, sugar must be present in large quantities.

Pasteurization.—Pasteurization is the heating of the food material in its container to a degree of heat necessary to kill only the adult form of microörganisms. Spores are not killed by this treatment. The temperature used varies somewhat with the length of time it is applied; 145° F. for thirty minutes is usually used in the pasteurization of milk. If a higher degree of heat is used a shorter time of exposure is needed, until at 160° F. only thirty seconds is necessary. Pasteurization is of the greatest value in the production of milk free from disease organisms, and such milk will keep sweet in the ice-chest for several days without appreciable change.

Cane Sugar.—Cane sugar is used principally in syrups and condensed milk. Besides its deterrent action on the growth of microorganisms it has also the added advantage of having a high food value. It is employed for the most part in the preparation of sweetened condensed milk, of which it makes about 40 per cent., and in the preservation of fruits whole and as jams, jellies and marmalade.

Salt. In addition to the attraction salt has for water in the tissues of meat and fish, salt also has a deterrent action on the growth of microorganisms, and is a necessary food substance as well. It is applied directly in the dry state or in the form of a brine. Even in this concentrated condition it does not always kill putrefactive organisms. It is used largely for pickling meats and fish. Sometimes saltpeter is added to increase its efficiency. Salt impregnates the whole tissue in time and therefore must be removed by soaking in water before the preserved food is palatable and suitable for consumption.

Vinegar.—Vinegar resembles sugar in being both a real food and preservative for food, and has been in use for centuries for these purposes. Its active principle is acetic acid. There are several varieties of vinegar, each having its own standard of purity, namely, cider, vinegar, wine vinegar, sugar vinegar, malt vinegar, distilled, grain or spirit vinegar.

Vinegar usually contains from 4 per cent. to 6 per cent. acetic acid. It is a general preservative for meats, fish, shell-fish, fruits, vegetables

and condiments. Pure dilute acetic acid may be substituted for vinegar, with satisfactory results, depending upon the type of food to be preserved.

The quantitative determination of acetic acid in vinegar is carried out by direct titration with a standard solution of alkali; usually tenth normal in strength. This gives the amount of acid present in terms of tenth normal acid, and may be readily calculated to per cent.

To fortify the acidity of vinegar, mineral acids are sometimes added, also wood vinegar (impure acetic acid from the destructive distillation of wood), substituted entirely or in part. This is a poisonous mixture and should have no part in food preparations. Special examinations for these forms of adulteration should be made in every vinegar examination.

Alcohol.—Alcohol acts as a preservative not only through its direct inhibitory action on organisms, but also as a protoplasmic poison of the corrosive type through its dehydrating action when used in strong solutions.

Alcoholic fermentation proceeds until about 15 per cent. of alcohol is developed, when fermentation stops. Larger quantities kill organisms not affected by the percentage which stops its own production. Alcohol is also a useful food and stimulant, practically all being oxidized by the body. It is used, for the most part, for preservative purposes in the home for the preservation of such foods as fruits (brandied peaches), mince pies and fruit cake.

Alcohol is determined quantitatively by distilling, from an alkaline solution of known volume (100 c.c.) and weight (specific gravity), an equal volume of liquid. This will contain the alcohol. The specific gravity of this distillate is determined and the percentage of alcohol present read off from the alcohol specific gravity table. From this percentage and the specific gravity of the original sample the amount of alcohol in the original sample is calculated.

Methyl, or wood alcohol, is sometimes used as a substitute and as an adulterant for ethyl or grain alcohol, and therefore an examination for methyl alcohol should always be included in an ethyl alcohol determination, since methyl alcohol is poisonous, producing in some instances blindness and death. Recently, "denatured" alcohol has been authorized for commercial purposes and for external medicinal purposes. Various substances soluble in alcohol are used to denature or make it unfit for drinking. Among these may be mentioned methyl alcohol, acetone, pyridine, furfurol, empyreumatic substances and formaldehyde. These compounds are unsuitable for food purposes and therefore alcohol used for preserving foods should be carefully examined for denaturants.

Benzoic Acid.—There is no preservative concerning which there has been so much debate as benzoic acid. Benzoic acid is practically always used in the form of its water-soluble sodium salt, sodium benzoate.

It is not burned by the animal body into carbon dioxide and water,

as are sugar, alcohol and vinegar, nor is it a normal constituent of the body. It is a phenol compound and is excreted as hippuric acid. Hippuric acid is excreted normally in small quantities in the urine, the body having a special mechanism for this purpose. It is not a food in any sense of the word.

Dr. Harvey W. Wiley's well-known experiments on laboratory workers tended to show that small quantities of benzoic acid, given in the form of the acid and sodium benzoate, produced digestive disturbances.

The Referee Board of Scientific Experts, repeating the Wiley Experiments, obtained results exactly contrary, and were of the opinion that sodium benzoate in quantities not greater than one-tenth of 1 per cent. was a harmless preservative for foods.

Benzoic acid is a white powder insoluble in water, but very soluble in ether. Its sodium and potassium salts are very soluble in water but insoluble in ether. The water solubility and cheapness of the sodium salt, together with its preservative action, make it available as a food preservative.

It is a weak preservative and is always fortified by the sterilization of the food product if it is intended to hold it for any length of time. Its principal use is found in catsup and similar condimental substances. It is rarely if ever used now in milk or pickling fluids.

Method of Separation and Identification of Benzoic Acid.—The substance under examination is either made alkaline and filtered and the solid residue thoroughly washed or it is acidified with hydrochloric acid and treated directly with the solvents.

The principle involved is that benzoic acid is practically insoluble in water, but soluble in ether and chloroform. The salts of this acid are insoluble in ether and chloroform but soluble in water. Therefore if one adds a little alkali (NaOH or ammonia preferable) to ensure any free benzoic acid being converted to its salt and then filters the salt will be in the filtrate, free from the solid mass of food material. The benzoic acid is then set free with hydrochloric acid and then extracted with ether. Or one may add directly to the product under examination a stronger acid (HCl) to liberate the benzoic acid from its salts. The choice of method depends upon the character of the material submitted for examination. In both methods the benzoic acid is finally separated by shaking with successive portions of ether in a separatory funnel.

The ether solution is filtered through dry paper to remove the last remnant of water. Ammonia is added to convert any benzoic acid present to a non-volatile ammonia salt and the ether is evaporated at a low temperature. It may be allowed to evaporate spontaneously at room temperature. In such a case the addition of ammonia is unnecessary and the final residue may be weighed. If ammonia is added to alkaline reaction, evaporate on the water-bath until all the ammonia is driven off. The residue is weighed for quantitative results and then tested with a few drops of ferric chloride. Ammonium benzoate gives a so-called "flesh colored" precipitate. Usually about 0.1 per

cent. benzoic acid as sodium benzoate, the U. S. Dept. of Ag. limit, is used by food manufacturers.

Volatile Matter in Smoke.—A large number of compounds are formed by the destructive action of heat upon wood, among these are: phenol, cresol, napthaline, benzol, toluol, methyl alcohol, formic and acetic acids, furfurol and many others. There is no doubt that if taken alone in concentration these volatile products would cause digestive disturbances of more or less severity. As they are applied to meat and fish only small amounts affect the tissues, so that any harmful effect due to the smoke is minimized. It is one of the oldest methods of preserving meat and fish, and, possibly for this reason, it has escaped the criticism of physiologists.

These volatile products of destructive distillation of wood are not foods. They are purely chemical preservatives, some of which would not be tolerated if taken under their true name for food preservation and the fact properly made known on the label, as the Federal law requires. Here is a large field for an important and practical investigation in food preservation.

Spices.—Spices owe their antiseptic value to the different essential oils they contain. As already quoted, these oils are real poisons when taken in their concentrated form. Usage again may be said to be responsible for the idea that they are real foods because they are derived from plants and herbs. They have the property of yielding hydrogen peroxide and ozone by slow oxidation in presence of air and water. But it is improbable that these compounds contribute appreciably to the antiseptic value of spices.

Spice extracts are used frequently. The powerful flavoring property of such extracts is a safeguard against their excessive use.

Formaldehyde.—Formaldehyde is the first product of oxidation of wood alcohol. It is a gas of powerful disinfecting properties, and is soluble in water up to about 40 per cent. at ordinary temperatures; in such a solution it is known as formalin. It is poisonous, uniting with protein to form compounds and alkali in the blood resulting in the production of formates. It has a hardening and tanning effect upon protein, rendering it insoluble in artificial gastric juice.

Formaldehyde has been sold and used extensively for the preservation of milk under the name of "preservaline." Formaldehyde is so powerful in its killing power that 1 part of formalin added to 50,000 parts of milk will keep it from souring for several days.

It has been used also as a deodorant for rotten eggs, and is to be suspected, wherever its use is applicable, in an investigation for preservatives in food.

The simplest test for detecting formaldehyde is the "Hehner test." This is applied to milk. It consists in underlaying a sample of the suspected milk with strong sulphuric acid of at least 90 per cent., containing some iron in solution. At the point of contact of the acid and milk a violet ring forms in a few moments, if formaldehyde is present. By this method 1 part to 50,000 is easily detected. It is sensitive up to 1 part formaldehyde to 500,000 parts milk.

Salicylic Acid.—Salicylic acid is not a food in any respect, though it occurs naturally in small quantities in some of our plant foods. Its effect upon the human was investigated by both Dr. Wiley and the Referee Board, resulting in the same conclusion that its action on the human was deleterious and that it should be condemned as a food preservative.

Salicylic acid is a white powder and is used usually as the soluble sodium salt. It exhibits the same properties toward solvents as those described for benzoic acid and its separation from food is carried out in exactly the same manner. The test-solution of ferric chloride, however, produces a claret red color, by which it is identified.

Boric Acid.—Boric acid has been a favorite food preservative. Like benzoic and salicylic acid it is found naturally in some foods, as previously mentioned, but unlike them it is a mineral acid and not an organic acid. It plays no part in the body. Experiments carried out under Dr. Park's direction on the feeding of kittens and white mice, in the Research Laboratory of the Department of Health of New York City, showed conclusively that it is an unfit substance to put into food. In these experiments the kittens without exception died, while the controls lived. The mice given boric acid in their food did not thrive and grow, while the control mice did.

Subsequently, Dr. Wiley and the Referee Board found in their tests upon humans that it produced digestive and other disturbances, and condemned it as a food ingredient.

It has been used in milk and has been allowed in butter, in minute quantities, by the English. All foods should be examined for boric acid in a systematic search for preservatives. It may be used in the form of its salt, borax.

The method for its identification in food is as follows: The food under suspicion is made alkaline, dried, ashed and leached out with water. This water solution is then filtered and acidified with hydrochloric acid. A strip of turmeric paper is moistened with this acid solution and dried on the steam-bath. In the presence of boric acid or borax the paper becomes cherry red, turning bluish green on the addition of a drop of dilute ammonia.

Fluorides.—Fluorine is used as a preservative in the form of a soluble salt, usually sodium fluoride. It is exceedingly corrosive, and in larger quantities is fatal in a few hours. Recently a fatal accident occurred in New York City through the mistaking of a roach powder for Rochelle salts. This powder contained 50 per cent. sodium fluoride.

It has been used at times as preservative of beer and vegetables and cannot be condemned too strongly for such purposes.

Fluorine is separated and identified in the following manner:

A weighed portion of about 100 gm. of a solid or semisolid food, or a measured portion of about 100 c.c. of a liquid food representing a fair sample, is mixed with calcium or barium hydroxide until alkaline. The mass is brought to dryness and ignited to an ash. This ash contains all fluorine in the sample examined. It is then transferred to a

small lead dish and treated with concentrated sulphuric acid, after which it is covered with a paraffined clock glass that has been marked with a sharpened wooden stick, thus exposing a portion of the glass. Fluorin by this process is freed from its barium or calcium salt and will attack the exposed glass, etching the figures marked by the stick in the paraffin. The action of the fluorine on the glass should be allowed to proceed for several hours to ensure as good a result as possible. After removal of the paraffin, care being taken not to scratch the glass, the glass is washed with alcohol thoroughly and dried, so that the etching which may be faint may be brought out clearly.

Fluorine belongs in the halogen group with the well-known elements chlorine, bromine and iodine, and has many properties in common with them.

Pyroligneous Acid (Liquid Smoke).—When wood undergoes destructive distillation in a closed retort, volatile liquid and solid products are obtained. Among the liquid products is pyroligneous acid, a substance of varying composition but containing phenol, creosote, and empyreumatic substances. It is used improperly as a preservative fluid for meats, sausage and fish by simply using it as a dip or applying it to the surface of the meat with a brush. It has no food value. It is poisonous when taken alone in appreciable quantities. It has no place in food preparations.

Formic Acid and Formates.—These compounds have been found occasionally in food products but, being relatively weak preservatives, are supplanted by the more efficient ones, such as benzoic and sulphurous acids. Formic acid is the oxidation product of formaldehyde, and is found in the urine of individuals poisoned by wood alcohol, when it may be considered as the indicator for wood alcohol in poisoning through an alcoholic beverage. Formic acid is found in certain varieties of ants in considerable quantities, and the poisoning due to the stings of the bee and wasp is attributed to formic acid.

When applied to the skin it is irritating and has been used in medicine as a counter-irritant. It may be considered as a true poison and therefore should never be used as a food preservative. It has a strong reducing action and probably its preserving action is due to this property.

It is separated from its mixtures after acidifying to free it from its salts, by distillation and is identified by applying tests, depending upon its reducing power.

Nitrates.—The nitrates, usually in the form of potassium nitrate, known as nitre or saltpetre, are used in pickling fluids. There is a difference of opinion regarding their effect on the human whether harmless or deleterious.

Saltpetre has been in use for a considerable time without exhibiting any noticeable bad effects, and for that reason it is allowed as a food preservative. It is, at best, a weak preservative.

Peroxides.—Hydrogen peroxide, and the peroxides of magnesium and calcium are very effective preservatives. They act through the

liberation of nascent oxygen with the formation of water, in the case of hydrogen peroxide, and the hydroxides of calcium and magnesium, in the case of peroxides of these metals.

They appear to be ideal preservatives for foods for which they are suitable and offer no objection, except the general objection to all chemical preservatives, that of abuse in their application.

Since peroxides break down so readily into substances that offer no means of proving the previous presence of a peroxide, it is extremely difficult to detect them.

Undestroyed peroxides may be detected in food by the following method: A sample of 100 gm. is acidified with sulphuric acid and distilled. The distillate will contain the hydrogen peroxide if present in the sample. The following tests may be applied to identify peroxide in this distillate:

Starch.—A potassium iodide (substituted for zinc iodide) starch solution is prepared, made by dissolving potassium iodide in a dilute starch solution. This solution when added to milk containing hydrogen peroxide gives a blue coloration depending upon the amount of the preservative present.

Paraphenylene Diamine.—This is made by dissolving 2 gm. of paraphenylene diamine in 100 c.c. of distilled water. A blue coloration is formed in milk in the presence of hydrogen peroxide when this reagent is added.

Benzidine.—A 4 per cent. alcoholic solution of benzidine is added to 10 c.c. of milk, previously made acid with 2 or 3 drops of glacial acetic acid, when a blue color is formed in the presence of hydrogen peroxide.

The experiments made in the Chemical Laboratory of the New York Health Department with the paraphenylene diamine reagent have been most successful.

Sulphurous Acid and Sulphites.—Sulphurous acid (SO_2) is the first product found by burning sulphur in air. It is partially oxidized, containing only two oxygen atoms in the acid radical SO_2. It is, readily oxidized to SO_3, and upon this depends largely its preserving property. The propriety of its use as a food preservative has been the cause of much controversy, and is still unsettled.

Dr. Wiley found, through feeding experiments on his squad, that it produced digestive disturbances. The report of the Referee Board has not yet been published.

It is used for a great variety of foods, both liquid and solid, such as meat and meat products, dried fruits, lime juice, cider, candy and molasses. It has the property of not only inhibiting and killing microörganisms, but of giving meat a fresh red appearance, and in this way covering inferiority.

It is used in the dried fruit industry not only to kill organisms, moulds and insects, but also to enable the manufacturer to add an excessive amount of water to the product, and it acts as bleaching agent, which improves the appearance of the product. This, of course, is a direct fraud. It also has the property of hardening glucose, which is used in making clear candy.

"Avisol" is a 30 per cent. solution of sulphurous acid, which has been on the market for a number of years and is used by candy manufacturers to give their clear candy greater "dryness" especially in warm weather. Analysis shows it to be present in quantities of about 0.01 per cent. or less in candy prepared with it.

There is no Federal law at present preventing the use of sulphurous acid, providing the food product bears a label declaring its presence.

Method of Separation.—Concentrated phosphoric acid is added to a weighed portion of the sample and the mixture distilled. Sulphur dioxide (SO_2) is liberated and distilled over into an oxidizing mixture of iodine or bromine, where it is converted into sulphuric acid. The sulphuric acid is precipitated with barium chloride as barium sulphate, filtered, washed, ashed, weighed and SO_2 calculated.

There are certain other methods that should be touched on in discussing food preservation, though they are only partially effective and unreliable. Lactic acid, a weak organic acid, produced by the fermentation of milk sugar, carbon dioxide, the violet ray and the electric current have all been used with more or less success.

Lactic Acid.—Lactic acid has the property of preventing the growth of many putrefactive organisms, and in this way is used as a preservative. Lactic acid is produced by the fermentation of milk by certain organisms, and products of this type known as koumis, kefir and matzoön, and other fermented milk products of the same general type are in general use. Some of these contain alcohol.

Metchnikoff proposed a system of intestinal disinfection based upon the presence of lactic acid in fermented milk, attributing the long life and good health of certain European mountain tribes to the use of this kind of food.

Lactic acid is also produced in the manufacture of sauerkraut, now known in America as "Liberty Cabbage," and is considered one of its valuable ingredients. It should be considered, when in proper proportion, as one of the legitimate food preservatives.

Violet Ray.—Organisms are killed by the violet ray when directly attacked by it. It has not been successfully applied to food, however, since particles of various kinds may act as a screen for the organisms.

Electricity.—The action of the electric current on water is to produce nascent oxygen. This method of killing organisms is practically the same as that of the addition of peroxides. If salt be present, the electrolytic action also produces sodium hypochlorite which possesses antiseptic properties.

Carbon Dioxide.—It has been observed in mineral water that carbon dioxide (CO_2) exerts a sterilizing action. This property has been utilized to some extent for other foods, both by replacing the atmosphere entirely or partially by the addition of carbon dioxide. Patents have been given for this method of food preservation, but it has not yet come into general use. Its action on foods has not been fully determined, though it would seem probably that such substances as milk might be altered through its action on the protein.

FOOD ADULTERATION.

It has been said that an army travels on its stomach, meaning that it is necessary to have a proper food supply for the army that it may travel and fight. It is equally true that a community or nation depends upon its food supply in order to thrive and prosper in its undertakings, and this food supply must be of the best quality and in sufficient quantity. It is unfortunate that whenever necessity arises there are always those who take the opportunity to add to their wealth at the expense and perhaps injury of their fellows. This is no more strikingly exemplified than in the food industry. It is probable that it has always been practised, but it has never been so scientifically practised as during the last fifty years. Within this period a more intimate knowledge of food properties has been gained, the studies of chemistry and physics have taken tremendous strides and practically all our knowledge of bacteriology has been developed. This marvelous increase in theoretical and applied learning has been of inestimable value in obtaining a larger and improved food supply for the world, but it has also given to unscrupulous food manufacturers and food dealers a means of degrading the food supply by methods that are correspondingly difficult to detect and to punish when detected.

Through the adulteration of food the quality is usually reduced, possibly harmful substances may be added or necessary natural ingredients reduced or abstracted, and in addition the profit is increased by substituting an inferior for a better article.

One of the most noteworthy steps taken to protect the American Food Supply resulted from the work done by the U. S. Department of Agriculture (1886 to 1891) and published as Bulletin No. 13, entitled "Foods and Their Adulterations," under Dr. H. W. Wiley chief chemist. This bulletin, or rather series of bulletins, covered all the principal groups of foods sold as human food and exposed the forms of sophistication practised. As a result of this publication a bill was introduced into Congress, by Mr. Heyburn, designed to prevent food sophistication. This bill was defeated, but was followed a few years later by another bill based principally upon the Heyburn bill. This was passed and became a law. It is popularly known as the Pure Food and Drugs Act of June 30, 1906. It is very comprehensive, and stands now practically as originally passed. Practically all the States of the United States have adopted this law, in whole or in part, so that though, as a Federal measure, it only deals with interstate and international commerce, its counterparts are efficacious in the various States.

Food adulteration, as defined by the Federal Pure Food and Drugs Act, falls naturally into the following groups, where the composition of the food itself is considered only:

"SEC. 7. That for the purposes of this Act an article shall be deemed to be adulterated:

In the case of confectionery: If it contain terra alba, barytes, talc,

chrome yellow or other mineral substances or poisonous color or flavor, or other ingredient deleterious or detrimental to health, or any vinous, malt, or spirituous liquor or compound or narcotic drug.

In the case of food:

First.—If any substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength.

Second.—If any substance has been substituted wholly or in part for the article.

Third.—If any valuable constituent of the article has been wholly or in part abstracted.

Fourth.—If it be mixed, colored, powdered, coated, or stained in a manner whereby damage or inferiority is concealed.

Fifth.—If it contain any added poisonous or other added deleterious ingredients which may render such article injurious to health: Provided, That when in the preparation of food products for shipment they are preserved by any external application applied in such manner that the preservative is necessarily removed mechanically, or by maceration in water, or otherwise, and directions for the removal of said preservative shall be printed on the covering or the package, the provisions of this Act shall be construed as applying only when said products are ready for consumption.

Sixth.—If it consists in whole or in part of a filthy, decomposed, or putrid animal or vegetable substance, or any portion of an animal unfit for food, whether manufactured or not, or if it is the product of a diseased animal, or one that has died otherwise than by slaughter."

The adulteration of which a food may be susceptible depends largely, and in many instances entirely, upon its nature. For this reason in discussing this question it is convenient to place foods in their natural groups from the standpoint of their composition, since each of these groups has many properties in common and hence has like forms of adulterants peculiar to each.

This holds true for foods in which these groups exist practically as individuals, or completely so, as in oils, sugars and meats, or where they are mixed in various proportions, either naturally or as manufactured articles.

The following are the general groups in which foods are usually placed:

1. Foods of a protein nature or those in which protein is the chief factor.

2. Foods of a carbohydrate nature or those in which starch and sugars are the chief factors.

3. Foods of a fatty nature or those in which fats and oils are the chief factors.

4. Alcoholic and non-alcoholic liquors.

Beside physical and chemical adulteration, the U. S. Department of Agriculture also includes false and misleading statements as to the quality and composition of foods in its conception of food adulteration as follows:

"SEC. 8.—That for the purpose of this Act an article shall also be deemed to be misbranded:

In the case of food:

First.—If it be an imitation of or offered for sale under the distinctive name of another article.

Second.—If it be labeled or branded so as to deceive or mislead the purchaser, or purport to be a foreign product when not so, or if the contents of the package as originally put up shall have been removed in whole or in part and other contents shall have been placed in such package, or if it fail to bear a statement on the label of the quantity or proportion of any morphine, opium, cocaine, heroin, alpha or beta eucaine, chloroform, cannabis indica, chloral hydrate, or acetanilid, or any derivative or preparation of any of such substances contained therein.

Third.—If in package form, the quantity of the contents be not plainly and conspicuously marked on the outside of the package in terms of weight, measure or numeral count: Provided, however-That reasonable variations shall be permitted, and tolerances and also exemptions as to small packages shall be established by rules and regulations made in accordance with the provisions of Section 3 of this Act. That this Act shall take effect and be in force from and after its passage: Provided, however, That no penalty of fine, imprisonment, or confiscation shall be enforced for any violation of its provision as to domestic products prepared or foreign products imported prior to eighteen months after its passage.

Fourth.—If the package containing it or its label shall bear any statement, design, or device regarding the ingredients or the substances contained therein, which statement, design, or device shall be false or misleading in any particular: Provided, That an article of food which does not contain any added poisonous or deleterious ingredients shall not be deemed to be adulterated or misbranded."

This label clause supplements the previous clauses dealing with physical and chemical methods of adulterations, thus expressing clearly and without equivocation what the U. S. Government considers forms of food adulteration.

The results following the enforcement of the Pure Food and Drugs Act have been so successful that the cases of gross adulteration as formerly practised, such as the use of poisonous metallic salts of brilliant color for coloring candy, the sale of diseased and putrid meats, the sale of rotten eggs to bakers for cakes, and the packing of decayed fruits and vegetables, have practically ceased.

Improved methods and modern sanitary factory conditions, employed by the present-day food manufacturer, have brought the American food industry up to a very high standard. But notwithstanding the best efforts of those interested in the production of the best food, there are always those who wilfully manufacture adulterated food and seek to cover it by skilful wording of the label.

Food adulteration as it now occurs is of a more subtle nature in

which the labeling and advertising matter accompanying it plays the principal part.

The use of improper material in food manufacture is best discovered by inspection at the source, and in some instances can only be discovered at the source, as, for example, the use of diseased cattle, hogs and sheep in the meat-packing industry. When diseased meat is trimmed, prepared and processed it is practically impossible to detect the lesions of disease. The same statement applies to the fruit and vegetable packing industry, the dried and condensed milk industry, the jam, jelly and preserve industry, not to speak of the pie, cake and bread industries, where practically nothing remains that is characteristic of improper ingredients. It requires the combined efforts of the food inspector, bacteriologist and chemist to safeguard our daily foods.

Probably the most important food is milk, since it is the only food for infants and the principal food for children and invalids. It is also the most general food for all classes and ages. The Federal, State and municipal laws covering the production and handling of milk are very precise and require that it shall be delivered in the same state as when taken from the cow.

The principal forms of adulteration of milk are extremely simple and largely practised. They consist in the removal of cream (skimming) and by watering. In this way the nutritional value of milk is reduced and the composition changed, so that physicians' instructions to mothers for modifying infants' milk cannot be accurately carried out. Milk must also be watched for the presence of preservatives, which usually are formaldehyde and borax. Other preservatives may also be found at times.

There is no food that needs such persistent and careful inspection as milk.

Meats of various kinds are sold in the raw and cooked condition, known as processing, or preserved by volatile products in smoke or by pickling. The use of diseased animals for food manufacturing purposes was formerly much more generally practised than at present, but even now some animals escape inspection that should be condemned for food purposes. It is almost impossible to say whether the meat of diseased animals after trimming and processing is harmful to health, but as long as there is any doubt the consumer should have the benefit of it. There is, too, the æsthetic standpoint which should be considered.

The chemist may examine meats and meat products for preservatives and poisonous metals derived from the containers, and the bacteriologist may examine them by appropriate methods for discovering injurious microörganisms, but neither the chemist nor bacteriologist is as effective as the inspector at the slaughter house and in the packing house.

What has been said of the importance of inspection at the source of meats holds also for the fish and poultry food industries since all these food substances are open to the same general conditions and susceptible to the same treatment. Rotten eggs are frozen and by the use of

formaldehyde deodorized for the food trade. This is a very repugnant practice.

There is no doubt about the danger from eating raw foods that have become infected with pathogenic organisms.

Investigations carried out by the Local Government Board in England have shown that practically in every case of illness due to protein food living, pathogenic organisms were the cause, and that ptomain poisoning due to protein split product almost never occurred.

Foods of a carbohydrate nature undergo alcoholic, acetic or other acid fermentation readily and hence preserve themselves after sufficient alcohol or acid is produced. The danger from pathogenic organisms from such types of food is very small, but, nevertheless, careful inspection is necessary to exclude rotten fruit and vegetables from canning or other food products, such as vegetables for chow-chow and catsup and pickles and fruit for jams and jellies. The use of such improper materials often necessitates the addition of preservatives to hold them from fermentation until they can be processed.

A microscopic examination of the finished product often shows enormous numbers of dead organisms, indicating the use of improper materials. The Department of Agriculture has put a limit on dead organisms as follows: Moulds, 66 per cent. of fields; spores and yeasts, 125 in $\frac{1}{60}$ c.c.; bacteria, 100 million in 1 c.c., and considers foods having counts greater than these adulterated. Many Government suits are based upon excessive counts successfully. The real objection to these foods is that they have been prepared carelessly or from unsuitable materials. The dead bacteria and the products of fermentation are not as a rule deleterious.

Fats and oils are extremely important food units. They furnish energy, save protein, and act as lubricants. In addition, they are absolutely necessary to health in a way not understood. This has clearly been demonstrated in Germany during the last two years of the war, and the attempt to substitute mineral oil as a lubricant was unsuccessful. The vitamin properties of oils and fats have only recently been known and the conditions necessary for healthful fatty products are still being studied. Some fats and oils contain a greater quantity of vitamins than others.

Butter is one of the most valuable foods for growing children, as well as for adults, on account of its vitamin content. The natural adulterant for butter is some foreign fat. The calorific value may remain the same in such mixtures, but the vitamin value is cut down and the money value is raised. Increased profits through adulteration, as pointed out, is practised with all foods, and is the cause for adulteration of foods.

As in the cases of protein foods, starchy and sugar-containing foods, a clean, healthy source is desirable and demanded of manufacturers and food dealers. Rancid fats and oils may be made salable after renovation, that is, by washing out the free acid. Such products may be safe foods, but they cannot be considered equal to fats and oils

that have not become rancid. Here, too, inspection at the source is indispensible in securing a proper product.

Though the control of food and foodstuffs by inspection at the source, with the assistance of the bacteriologist, is of the greatest importance, the chemical control of the manufactured product is also very important not only to determine whether any injurious metallic substances, coloring matter and preservatives are present, but also to determine whether the label tells the truth as to the contents of the products.

In protein foods, metal dissolved by tissue juices from containers may be an important factor, or preservatives not stated on the label may be present.

Incomplete processing may result in decomposition after packing and may be identified by chemical processes. Foods of a starchy nature, or those with a large proportion of sugar, unless well processed, will undergo decomposition, which may be determined by chemical methods. Substitution may occur in certain kinds of foods. Honey has long been a favorite in this respect, glucose and cane sugar syrup being substituted wholly or in part for honey. The vitamin value of honey, though small, must be of importance, and this will be decreased by the addition of glucose and cane syrup. Maple sugar is another favorite for adulteration. Here one finds brown or unpurified cane sugar often substituted. When maple sugar sells at 25 cents per pound and brown sugar at 6 cents per pound it will be readily seen how profitable this adulteration may be.

Canned fruits and vegetables may contain preservatives to help out improper or cheaper methods of manufacturing.

Alcoholic beverages sometimes are adulterated with wood alcohol. This form of adulteration is very dangerous to life and health. Some alcoholic beverages are found to be entirely synthetic, though bearing a label indicating well-known brands. Crême de menthe is very easily adulterated in this way.

Cider is often watered. It is sometimes made from apple pulp, and in many cases has some preservative added.

Artificial mineral waters are notorious for being adulterated. There are but few manufacturers that use formulæ that correspond to the analyses of the natural waters from which the names are derived. Vichy and Seltzer waters often contain only a little salt, whereas the original waters are very complex in composition. Such adulterations are pure frauds and illustrate the great mass of food adulterations found on the market today.

It might be noted that any apparent relaxation of the food authorities is followed by poorer grades of food found on the market. Actual harmful food adulteration is seldom found, but deceitful labeling of low-grade foods is still not uncommon.

CHAPTER XII.

BACTERIAL AND OTHER CONTAMINATIONS OF MILK. THEIR RELATION TO PUBLIC HEALTH.

By WILLIAM H. PARK, M.D.

Fresh clean milk from the healthy, properly fed cow is thoroughly wholesome for children and adults, and while it is not a perfect substitute for human milk in infants, it is the best substitute. Milk when obtained from a diseased or improperly fed cow, even though fresh and clean and free from contagion, is frequently deleterious for infants and is sometimes so for adults. When contaminated with excessive numbers of the ordinary saprophytic bacteria which have developed from those gaining access to it during milking, it is distinctly dangerous for infants, especially in hot weather, but usually not appreciably so for adults. When it is a vehicle for pathogenic bacteria it brings danger to all who consume it.

Cities' Milk.—Milk when consumed in towns and cities is never fresh from the cow, and rarely delivered directly by the producer to the consumer. The farms from which a large city's milk must come are pushed further and further away with the increase of population. Thus the daily supply of nearly 2,000,000 quarts for New York comes from five States. Almost all of it is from a distance of more than fifty miles, and a considerable amount is hauled more than three hundred miles. The time between the production and the consumption of the milk in the larger cities is from twenty-four to sixty hours, and in the smaller towns and cities from six to thirty hours. The producer and the consumer being unacquainted with each other, there is no possibility of the latter knowing from personal inspection how this milk is produced. The producer being unacquainted with the consumer has little personal interest in him, and feels little or no responsibility as to the quality of his milk and has little fear of detection if sickness is produced through it.

The solving of the problem of giving to a people a safe milk requires that the conditions at the seat of production, on the transportation lines, at the stores and in the houses be correct in all essentials. There are few food problems which present as many difficulties as that of the giving of a wholesome milk at a reasonable price to consumers who are at a distance from the producer.

People have learned by bitter experience that whenever the milk has to be obtained from distant and largely unknown sources there is need of responsible control to regulate the methods for the production

and distribution of milk. The conditions which develop when this oversight is lacking were brought to the attention of the public as long ago as 1842 in a book published by Robert M. Hartley on the milk supply of New York City. He disclosed the appalling fact that the greater part of the milk consumed in the city at that time came from cows kept in wretched habitations and fed wholly on distillery waste. The results developing from the use of such milk were very serious in the destruction of infant life.

Young children as well as infants, who consumed this milk, suffered seriously in health. The milk secreted by these cows was shown by chemical examination to differ markedly from normal milk. The effect of the disclosures concerning the harmfulness of this milk brought about a widespread reform which prohibited not only the use of distillery waste, but also of fermented grains, slops, etc. These measures eliminated the principal causes of the secretion of deleterious chemical substances with the milk. From time to time other foods have been discovered which when consumed lead to the production of poisonous milk. The feeding of corn before it has blossomed, of improperly prepared or rotten ensilage or even good ensilage in amounts beyond a daily ration of 30 pounds, of putrefying food, of other improper rations, of food infected with ergot, all cause the cow to secrete a milk which may cause diarrhea or other illness in young infants. Cows which are sick from various diseases will often secrete a milk which is deleterious. Harmful chemicals may be added accidentally to milk unless care has been taken that the containers for cooling, holding and transporting milk have no exposed metals which can be dissolved, such as copper and lead. Besides these contaminations of milk, substances are added deliberately to it in order to preserve it, to change its appearance or to dilute it.

The addition of germicidal substances to milk is illegal in almost every community; yet it must be conceded that some of these in small amounts are probably harmless, while others are distinctly poisonous. I have watched infants throughout a summer which were fed on one part of formaldehyde to twenty thousand parts of milk, and did not observe that they suffered in the slightest. Kittens grew to adult size on such milk in perfect health, and their tissues when examined under the microscope appeared to be perfectly normal. The digestive enzymes have been found by investigation not to be interfered with by a moderate amount of several other antiseptics. In spite of the harmlessness of the addition of small amounts of formaldehyde or of certain other bactericidal substances, the practice is universally condemned because of the difficulty of controlling the amount and varieties used. Fortunately, milk obtained in a cleanly manner and kept sufficiently cold reaches the centers of population in good condition. This necessitates a sufficient supply of ice which may not be obtainable in the southern sections of the country. The additions of water, gelatin, calcium compounds, etc., to milk and the abstraction of cream, although harmless, are properly prohibited because they are

done for fraudulent purposes in the endeavor to make a milk appear richer than it is. The methods which a city successfully uses to prevent these practices is to take samples from time to time and to inflict heavy fines, or withdraw the license, when adulteration is detected.

THE RELATION OF BACTERIA TO MILK-BORNE DISEASES.

It is only fairly recently that the danger of the usual bacterial contamination of milk has been understood. Many of the early precautions, however, which were insisted upon in the care of milk supplies by health authorities owed their value to keeping bacteria out of the milk or to preventing them from developing in it.

Milk provides a good soil for growth for a great many varieties of bacteria. The ordinary bacteria of the soil and the manure are the most commonly found in it, but those from diseased animals and men occasionally gain access and remain alive or proliferate and excite specific diseases. While some of the saprophytic bacteria produce harmful products, others produce those that are harmless. The custom in Eastern Europe of drinking milk soured by different lactose fermenting bacteria, which has lately been transmitted to Western Europe and to us and become almost a fad, strikingly impresses the fact that certain varieties of bacteria are not only not harmful to swallow to the extent of many billions, but even beneficial. These bacteria probably do good by displacing other less desirable bacteria from the intestines or by beneficially altering certain food substances during their growth and activities. The acidity produced inhibits to some extent the growth of human pathogenic bacteria. Unfortunately, there are almost always in the air and dust of the ordinary barn, besides the wholly harmless varieties, intestinal and other bacteria which produce disagreeable and often deleterious substances, so that ordinary milk, when soured ("buttermilk"), is frequently dangerous when given to young infants. This is especially true if the milk is kept at a temperature above 60° F. At a temperature of 80 or higher powerful poisons are sometimes produced. Some of these are harmful to adults as well as to children. In milk kept at low temperatures, of 50° F. or under, products of bacterial growth are usually harmful for infants only.

Even in infants the usual types of bacteria do little harm in cold weather; it is only in hot weather, when the resistance of the digestive tract is lowered, that these saprophytic bacteria and their products cause serious harm. It is true that the actual number of bacteria is on the average much higher in the milk in summer, but where infants have taken milk of the same quality and containing approximately the same number and kinds of bacteria the same marked difference occurs in the two seasons.

As some still attribute the increased diarrhea almost wholly to the bacteria, we will consider why the effect of heat on the infant's resistance and of cows' milk as an imperfect substitute for human milk are

equally important factors during the hot months of the year. I once had the opportunity of observing the health of the very young children in an infant asylum. These children received milk from a nearby farm and the bacterial count was always low. During cool weather almost no diarrhea occurred. With the onset of warm weather in June a few of the smaller infants developed some illness. During July the cases of diarrhea increased, these reached the maximum early in August when several deaths took place. With cool weather diarrhea again ceased. In this instance, with all factors constant except temperature, disease came and went with the hot weather. An actual experiment observed by me brought out, on the other hand, the harm that the bacteria in the milk produce.

A group of fifty babies were being fed on a milk pasteurized at 160° F. for twenty minutes. Late in June half of these babies were given the same supply of milk, but without previous heating. The living bacteria in the heated milk averaged about ten thousand per cubic centimeter, while the unheated contained about one million. There was immediately a marked increase in the diarrhea in the half getting the unheated portion of the milk. Some of the infants had to be put back on the heated milk before the diarrhea could be controlled. These two instances are only examples of the experiences which all investigators have had. Heat and humidity predispose the infant to intestinal diseases, which cows' milk as such tends to aggravate. While it is true that the bacteria in the intestines or those introduced through water may under such favorable conditions excite diarrhea, still it usually requires in addition the giving of cows' milk with excessive numbers of living bacteria or marked chemical changes due to bacterial decomposition.

In order that each reader may satisfy himself of the validity of the above conclusions as to the effect of saprophytic bacteria on milk I record here a full abstract of the observations made on infants consuming milk of different degrees of purity.

BACTERIOLOGICAL INVESTIGATION OF THE MILK USED IN FEEDING.

The clinical work was carried on in conjunction with a bacteriological study of the milk used, in order to determine whether any relationship existed between the number and character of the microorganisms in milk, and the amount of diarrheal disease in the children to whom it was fed. Bacterial counts were made once or twice a week from the milk as given to each child, specimens being taken at times from the raw and at times from the heated milk.

The bacteria were isolated from the milk through plating in a 2 per cent. lactose-litmus-nutrient-gelatin, or agar, and later grown upon the usual identification media. The pathogenic properties of the different bacteria were tested by intraperitoneal and subcutaneous inoculation in guinea-pigs with 2 c.c. of a forty-eight-hour broth culture,

and by feeding young kittens for several days with 3 to 6 c.c. daily of twenty-four-hour broth culture by means of a medicine dropper.

The varieties isolated represent only the species present in greatest number in the milk examined, for in no case was more than 0.01 c.c. of a milk, and in most highly contaminated milks, only 0.001 c.c. used in making a plate, and varieties which occurred in too small numbers to be present in this quantity would necessarily be missed.

During the investigation a number of the varieties isolated from milk were shown to be identical with types commonly found in water.

As a matter of fact, it was found that milk taken from a number of cows, in which almost no outside contamination had occurred, and plated immediately, contained, as a rule, very few bacteria, and these were streptococci, staphylococci and other varieties of bacteria not often found in milk sold in New York City; the temperature at which milk is kept being less suitable for them than for the bacteria which fall into the milk from dust, manure, etc. A number of specimens of fairly fresh market milk averaging 200,000 bacteria per c.c. were examined immediately, and again after twelve to twenty-four hours. In almost every test the three or four predominant varieties of the fresher milk remained as the predominant varieties after the period mentioned.

The above experiments seem to show that organisms which have gained a good percentage in the ordinary commercial milk at time of sale will be likely to hold the same relative place for as long a period as milk is ordinarily kept. After the bacteria pass the 10 or 20 million mark, a change occurs, since the increasing acidity inhibits the growth of some forms before it does that of others. Thus some varieties of the lactic acid bacteria can increase until the acidity is twice as great as that which inhibits the growth of streptococci. Before milk reaches the curdling point, the bacteria have usually reached over a billion to each c.c. For the most part specimens of milk from different localities showed a difference in the character of the bacteria present, in the same way that the bacteria from hay, feed, etc., varied. Even the intestinal contents of cows, the bacteriology of which might be expected to show common characteristics contained, beside the predominating colon types, other organisms which differed widely in different species and in different localities. Cleanliness in handling the milk and the temperature at which it had been kept were also found to have had a marked influence on the predominant varieties of bacteria present.

Pathogenic Properties of the Bacteria Isolated.—As bacteria in milk are swallowed and not injected under the skin, it seemed wise to test the effect of feeding them to very young animals. We therefore fed forty-eight-hour cultures of 139 varieties of bacteria to kittens of two to ten days of age, by means of a glass tube. The kittens received 5 to 10 c.c. daily for from three to seven days. Only one culture produced illness or death.

After two years of effort to discover some relation between special varieties of bacteria found in milk and the health of children, the conclusion has been reached that neither through animal tests nor the

isolation from the milk of sick infants have we been able to establish such a relation. Pasteurized or "sterilized" milk is rarely kept longer than thirty-six hours, so that varieties of bacteria which after long standing develop in such milk do not enter the problem. The harmlessness of cultures given to healthy young kittens does not of course prove that they would be equally harmless in infants. Even if harmless in robust infants, they might be injurious when summer heat and previous disease had lowered the resistance and the digestive power of the subjects.

This failure to discover definite pathogenic bacteria, in more than one culture as well as the numerous varieties of bacteria met with, have forced us to rely on the clinical observation of infants to note what difference, if any, occurred in those fed on raw and pasteurized milk from the same source, and upon different milks of unknown origin varying in the number of bacteria contained. In the following pages, observations upon food are combined with those upon other factors which influenced the health of the infants.

Selection of the Children for Observation. —The original aim was to include only infants who were entirely bottle-fed, but it was found that the great majority of all infants in the tenements receive during the first six months occasionaly breast feedings at night, and nearly all are given some solid food after they are six months old, or as soon as they are able to hold it in their hands. The purpose of the investigation being to obtain relative results with different forms of milk and not absolute results with one form, it is believed that the conclusions reached are not affected by the fact that many of the infants received breast feeding at night. Indeed including such infants has the advantage of studying representatives of a very large class. In each season some infants who were entirely breast fed were observed for purposes of comparison.

In selecting the children the only conditions made were that they should not be ill or suffering from marasmus when observations were begun, and that they should be of suitable age. Of the entire number 340 were six months old or under, 265 were from seven to twelve months; 47 were a little over twelve months. With the exceptions stated, every child available was included by the physicians until the proper number was made up. The district in which most of the children lived was the lower East Side of New York, as densely populated as any part of Manhattan Island.

The Character of the Food Employed.—It was at first intended to make no change in the food the child was receiving, but it was found necessary in order that observations might also be made upon the comparative effects of heated and unheated milk in summer to place a number of infants upon a modified raw milk provided for them which was a part of a larger supply distributed to others after pasteurization. When gastro-intestinal disturbance of any severity developed, the infants were deprived of milk for a day or two and put on barley water or other suitable food.

In the district where the observations were made the following forms of milk were extensively used: (1) Condensed milk; (2) milk purchased at small stores with groceries and other provisions and known as "loose raw store milk;" (3) raw bottled milk; (4) pasteurized milk from central distributing stations.

Condensed Milk.—That used was usually the sweetened variety. It was generally prepared at each feeding by adding hot water which, in most cases, had been boiled.

FIG. 44.—Loose milk supply sold in a grocery store. Without a separate milk room it is difficult to prevent contamination

Store Milk.—It is kept in large cans in the small stores. It averages about 3.75 per cent. of fat. It is customary for milk to be purchased twice a day and it is carried home and kept in pails or pitchers. In summer it is usually heated at once; if it curdles, it is considered to be unfit for use and returned. Heating is usually done in a sauce-pan and the temperature is raised to a point where the milk begins to "foam," seldom to boiling-point. In most cases it is kept upon ice. It is usually prepared for the infant at each time of feeding. The only modification practiced is, in most cases, dilution with water or barley water, equal parts being as a rule given when infants are about three months old and continued until ten or eleven months, when whole milk is given.

The bacteriological examination made of this milk during the summer of 1901 showed it to contain from 4,000,000 to 200,000,000

microörganisms, an average of about 20,000,000 per c.c. The form of heating employed killed, it was found, about 95 to 99 per cent. of the bacteria present. During the winter the number of bacteria ranged from 100,000 to 5,000,000 bacteria per c.c., and averaged about 400,000 per c.c. Milk of this character has been largely eliminated from the larger cities because of pasteurization.

Bottled Milk.—The greater part of the bottled milk was produced under conditions which were only fairly good. However, it was so well handled during transportation and delivery that it was nearly always in good condition when received by the consumer. This milk averaged about 500,000 bacteria per c.c. The same general plan of modification was practiced as with the store milk.

Milk from Central Distributing Stations.—The greater part of this milk was supplied from the Infant Milk Depots of which there are a number scattered through the city, and a small quantity from diet kitchens. The milk used at these places was generally of excellent quality, usually from a "certified" farm, but it was mixed with poor cream. This milk, after the addition of cream, averaged, before pasteurization, about 2,000,000 bacteria per c.c.; after pasteurization, about 500 per c.c.; after boiling, about 5 per c.c. It is supplied in small bottles, each one containing the quantity for a single feeding. The bottles are washed and sterilized at the central stations. Some attempt at modification was made, three or four standard formulas being used. The common modification consisted in the dilution with boiled water, the addition of lime water, milk sugar, and, in some cases, cream also; or the dilution with barley water and the addition of cane sugar. Regarding the use of these formulas, the quantity for one feeding, and the number of feedings daily, directions were usually given by the physicians in attendance at the Central Stations. As the mothers came daily for their milk, some constant supervision of the cases was thus possible, and many minor disturbances of digestion no doubt controlled by a proper variation in the food.

Breast Feeding.—As already stated, the great majority of infants reared in tenements are breast-fed, at least for the first six months. No effort was made to collect many observations upon these children, but a few were introduced for the sake of comparison. It was thought at first to make a separate division of the children who were partly breast-fed, as it was the impression of some of the physicians who followed the cases that a decided difference existed between those who were partly nursed, usually at night, and those entirely fed. However, the general figures when tabulated did not show any very marked difference. The results seem to have depended rather upon the character of the other food.

In estimating the results obtained by the different methods of feeding two things were considered: first, the gain or loss in weight, and secondly, the amount of digestive disturbance, particularly diarrhea, which occurred in the different groups of infants. The cases have been divided according to results in four groups:

1. Those which did well. In this group are included the infants who made a substantial and generally a regular gain in weight during the period of observation, this usually amounting to from two to five pounds for the ten or twelve weeks, and those that had no diarrhea worth mentioning—usually both conditions existed together.

2. Those which did fairly, including those in which some diarrheal disturbance was present, but not of a serious nor prolonged character, and in which the weight was either stationary or the gain very slight. Both these generally went together.

3. Those which did badly, including those in which considerable digestive disturbance, usually diarrhea, was present, or in which there was a loss in weight; generally here also both factors existed.

4. The fatal cases.

The following tables show in a condensed form the results obtained with the different foods employed in winter and in summer.

FOOD AND RESULTS.—WINTER.

	Did well.	Did fairly.	Did badly.	Died.	Totals.
Store milk	47	6	2	0	55
Condensed milk	39	5	2	2	48
Good bottled milk	51	13	1	3	68
Milk from Central Distributing Stations	35	20	4	0	59
Best bottled milk	5	0	1	0	6
Breast feeding	7	1	0	1	9
Totals, excluding cases counted twice	156	41	8	6	211

FOOD AND RESULTS.—SUMMER.

	Did well.	Did fairly.	Did badly.	Died.	Totals.
Store milk	21	23	20	15	79
Condensed milk	22	20	14	14	70
Good bottled milk	37	23	29	9	98
Milk from central distributing Stations	84	33	24	4	145
Best bottled milk	9	3	0	0	12
Breast feeding	17	7	7	0	31
Totals, excluding cases counted twice	184	108	88	41	421

Season and Results.—Nothing could be more striking than the contrast between the results in winter and in summer. The general summary shows that of the 211 winter cases, 156 did well; 41 did fairly, 8 did badly, and 6 died. In other words, what might be considered good results were shown in 93 per cent. of the cases, and bad results in only 7 per cent. Furthermore, in only one of the six deaths was the cause connected with the digestive tract.

Of the 421 summer cases, 184 did well, 108 did fairly, 88 did badly and 41 died. In other words, good results were obtained in 69 per cent. of the cases and bad results in 31 per cent., while in nearly all of the fatal cases death was due to diarrheal diseases. It should be remembered

that all the children, both winter and summer, had the advantage of some continuous intelligent oversight, usually one visit a week and often two being made by the physicians. This supervision contributed in no small degree to the results in both groups of cases.

The showing made by the winter cases is most gratifying and was indeed a surprise to all.

To what shall be ascribed the great difference between summer and winter results? There seem to be many factors, but a consideration of the facts accumulated indicate that heat is the primary factor and bacteria and their products a secondary one, except when the contamination is extreme or pathogenic organisms are present.

The effect of continued heat upon the health of infants is shown in the number of cases of diarrheal diseases and the number of deaths during the months of the summer of 1901 in an institution in the country near New York City, where a pure milk was fed raw. During the winter and spring there was almost no diarrhea; with the warm weather of June it increased, reaching its highest point in August. The comparative results with the breast and bottle-fed infants are also evident.

Month.	No. of infants.	Food.	Deaths.
June	34	Breast milk	0
	25	Cows' milk	0
	38	Breast and cows' milk	0
	128[1]	Milk and barley food	0
Total . .	225		
Number of cases of diarrhea, 15; deaths, 0.			
July	32	Breast milk	0
	20	Cows' milk	3
	38	Breast and cows' milk	0
	124[1]	Milk and barley food	0
Total . .	214		
Cases of diarrhea, 38; total deaths, 3 (all bottle-fed).			
August	28	Breast milk	0
	18	Cows' milk	3
	32	Breast and cows' milk	4
	129[1]	Milk and barley food	2
Total . .	207		
Cases of diarrhea, 50; total deaths, 9.			

Food and Results.—1. **Store Milk.**—The largest number of bad results were seen, as was expected, with the cheap store milk, where not only was the milk poorer, but the care at home less.

2. **Condensed Milk.**—The results with condensed milk can hardly be attributed to the bacteria, inasmuch as it was almost invariably prepared with boiled water and contained relatively a small number of microörganisms before heating. These children were often apparently in good condition until attacked with acute disease, when they offered

[1] Those on milk and barley food were all over twelve months old.

but little resistance and seemed to succumb more quickly than any other class of patients. In one family three healthy infants, triplets, five months old, were taken sick on the same day with vomiting and diarrhea; one died within twenty-four hours, one within two days, and the third within a week. A bacteriological examination of the prepared milk remaining in one bottle showed nothing noteworthy.

3. **Bottled Milk.**—The better results observed with bottled milk should not be put down as entirely due to the character of the food. The people who purchased it were seldom so poor as those buying store milk; they were usually more intelligent and probably more careful in handling the milk.

It is interesting to compare these results with those of store milk just preceding them in the table. The percentage mortality with the better grade of milk is only about one-half that seen with either condensed or store milk, and yet the large number of infants who did badly brings the proportion of bad results with bottled milk almost up to that with the two preceding varieties. It was noteworthy, however, that among infants included as doing badly there was on the average less sickness than among those fed on store milk. It would seem, therefore, that good bottled milk, as now used, while much less dangerous to life than cheap store milk, is still, judging by this proportion of failures, rather unsuccessful as a method of feeding.

4. **Milk from Central Distributing Stations.**—The great difference between these results and those obtained with the three forms of feeding already considered deserves special attention. The original milk used at the stations was of good quality, but not much better than the bottled milk generally used; with both some form of sterilization was practised. The difference in results is not explained by the difference in these two factors. There were others of importance which must be sought. A certain amount of constant supervision was exercised over these infants, as some one, usually the mother, came daily to the milk dispensary for the food. Changes could thus be readily made in the milk according to the child's condition. If symptoms of slight indigestion were present, the mother was instructed to dilute the milk; with more severe symptoms, milk was temporarily stopped, etc. This supervision seems to us of the greatest value and can hardly be secured so well in any other way. Again, a mother sufficiently interested in her baby to come or send daily several blocks for the milk is generally one who values what she receives and also the advice which goes with it. This food, obtained in separate bottles for each feeding, is generally regarded by the tenement population as not exactly milk but as something very special, and therefore entitled to much more consideration than any form of food which they could prepare themselves at home.

Another point of importance is that some systematic attempt at milk modification was made in the milk furnished from central stations. Although this could not be done as accurately as for a smaller number of patients, the results were certainly improved by it. Again, what

contributed in no small degree to success with this plan of feeding, was that this milk was supplied in separate bottles for each feeding, that the quantity for one feeding was suitable for the child, and that only a proper number of feedings for the twenty-four hours was dispensed at one time. There was not, therefore, the temptation to over-feeding and too frequent feeding, which with other methods are so generally practised. Finally, the bottles in which it was kept were always properly cleansed and sterilized, since this was attended to at the central station.

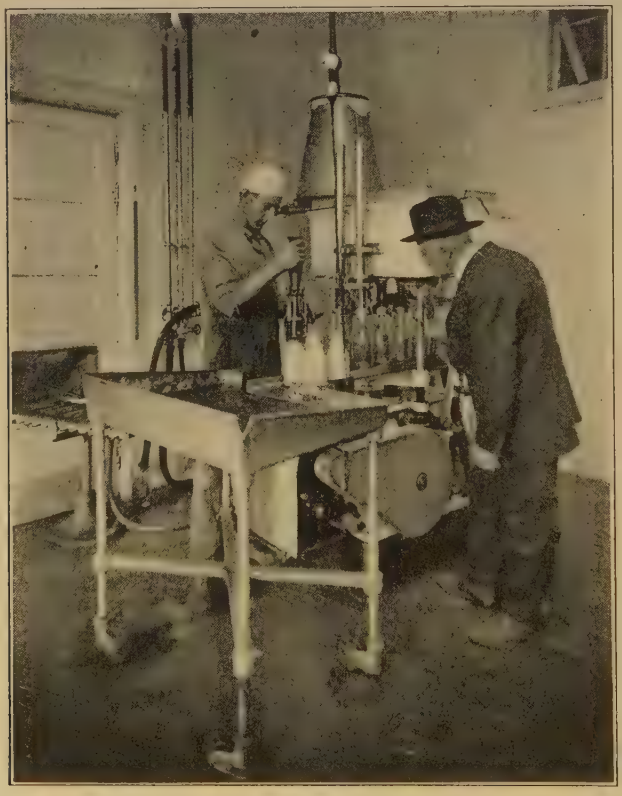

FIG. 45.—Cooling, filling into bottles and capping a Grade A milk supply.

5. **Best Bottled Milk.**—This was furnished to 18 infants living in the tenements, to discover whether any perceptible difference existed between the results with this milk and the other varieties. While these observations are not numerous enough to admit of any generalizations, they indicate what was previously believed, that, with the cleanest milk from the best cared for cattle, the smallest number of bad results occurred.

The difference between very bad, highly contaminated milk, like that purchased at some of the small stores previous to 1902, and the

best bottled milk, was in some cases very striking. Protracted diarrhea in infants who were taking store milk was often immediately improved and in several cases promptly cured by simply substituting clean milk (after an interval of no milk) for the previous food. In some severe cases, however, no improvement followed the purer milk.

Age and Results.—In 17 cases the ages were not recorded. Of the summer cases 217 were infants under six months; 191 were between six and twelve months, and 47 were over twelve months. The comparative results for the different ages are shown in the following table.

AGE AND RESULTS.—SUMMER.

Age.	Did well, per cent.	Did fairly, per cent.	Did badly, per cent.	Died, per cent.
Under 6 months	52	16	19	13
7 to 12 months	34	32	26	8
Over 12 months	49	32	19	0

Of the winter cases 123 were infants under six months, and 74 from seven to twelve months; none was over twelve months.

AGE AND RESULTS.—WINTER.

Age.	Did well, per cent.	Did fairly, per cent.	Did badly, per cent.	Died, per cent.
Under 6 months	74	21	0	5
7 to 12 months	70	20	10	0
Over 12 months				

These figures indicate a considerably higher mortality in infants under six months, but a surprisingly large proportion of infants over this age who did badly. In summer, other factors than the milk used must be taken into account, one of the most important being the unwise giving of table food to infants over six months old, a practice which is almost universal in the tenement population. Giving fruits even to infants is also an important cause of illness. This was strikingly seen among the Italians. In this class of the population it was the opinion of some of the physicians who observed these cases, that the use of fruit, often unripe, stale or partly decayed, was the cause of more illness in infants and young children than the impure milk.

A separate study has been made of the cases which did badly, and the fatal cases, to determine any other factors beside the food and age which contributed to the results. An attempt was made to discover what sort of care these infants received, what their surroundings were, and whether the results in feeding were due to conditions or diseases outside the digestive tract.

Fatal Cases.—Of the 632 children observed, 47 or 7.5 per cent. died during the three months of observation. The mortality of the 211 winter cases was 2.8 per cent.; of the 421 cases, 11.3 per cent. Of infants under one year, neither in the age nor the previous conditions do we find any sufficient explanation of the fatal result. In the 47 observed who were over one year, no deaths occurred. The care which the fatal cases received is significant. Only 16 of the 47 infants who

died received good care, and 19 were recorded as positively neglected. In 21 of the cases the surroundings were bad. The causes of death in the fatal cases were as follows:

Disease.	Summer.	Winter.
Diarrheal diseases	32	1
Pneumonia	5	2
Tuberculosis	2	0
Rickets	1	0
Diphtheria	1	0
Maramus	0	1
Accident	0	1
Unknown	0	1
	41	6

The winter case having diarrhea was fed upon good bottled milk sterilized, and had gastric as well as intestinal symptoms. The marasmus case was a child fed upon condensed milk. In only two of the winter deaths could the result be definitely connected with the feeding; while in summer this was true of 30 of the cases.

OBSERVATIONS UPON THE FEEDING OF RAW MILK IN OLDER CHILDREN.

The children over three years of age who received unheated milk, containing at different times from 145,000 to 350,000,000 bacteria per c.c., showed almost no gastro-intestinal disturbance.

PROPORTION OF INFANTS THAT CONSUME COW'S MILK.

From investigations it is estimated that during the first nine months of life nearly 80 per cent. of infants are entirely or chiefly breast fed. From a study of these figures we discover that improvement in the milk supply can only affect about 20 per cent. of infants under nine months. This is the period during which most deaths occur from intestinal diseases. Dr. Cronin tabulated 1000 consecutive deaths from enteritis under two years and found 81 per cent. were under nine months, 13 per cent. more occurred during the next three months, and only 6 per cent. in the second year.

The danger of cow's milk in infants was brought out by the discovery that although more than 75 per cent. of infants are nourished on mother's milk, 78 per cent. of the 1000 infants dying of enteritis were fed on cow's milk or patent foods.

General Conclusions.—In addition to the statistical reports of their observations, the different physicians who watched the infants in their homes were asked to state their own conclusions regarding the general problem of infant-feeding in the tenements. These general impressions are most suggestive and cannot fail to be of interest to all who are working at this difficult problem.

It was practically the unanimous opinion that the most important factor in securing good results is intelligent care. This covers much:

clean bottles and nipples; the willingness and ability to carry out directions as to methods of feeding, quantities, frequency, the stopping of milk at the first signs of serious diarrhea, etc.; proper care of the milk itself while in the house, and methods of sterilizing; suitable clothing and cleanliness of the children, and as much fresh air as possible. An excellent ice-box to keep milk cold was devised by Hess. An ordinary box has in its center a piece of tin or linoleum. The space between is filled with sawdust. The cover is padded with an inch of newspapers.

FIG. 46.—Hess refrigerator.

Most of the physicians stated that, leaving out the very worst store milk in summer, the results were much less affected by the character of the milk than they had anticipated, and distinctly less than by the sort of care the infants received.

The surroundings alone had much less influence on results than was anticipated. For not only were breast-fed infants found doing well under the most unfavorable surroundings, but those also who received only the bottle as a rule did well, provided they received intelligent care and good milk.

The depressing effects of great atmospheric heat, *i. e.*, a temperature in the neighborhood of 90° F., or over, were very marked in all infants no matter what their food. Those who were ill were almost invariably made worse, and many who were previously well became ill. A bad method of feeding, or rather a feeding without any method, was

responsible for many failures when the milk itself was of good quality. Common mistakes were: feeding an infant every time it cried; giving it a full bottle no matter what the age of the child, and letting it take as much as it would; preparing a large bottle of food at one time, and warming it over from time to time until the child had taken the whole of it, or allowing the milk to turn sour in the feeding bottle. Quantities proper for single feedings were almost invariably disregarded. Proper washing of feeding bottles was seldom seen in a tenement house. Such matters as these are closely connected with intelligent care, which has been already considered.

The importance of the matters just mentioned, raises the question of how much can be accomplished by the distribution of printed slips of directions. It was the observation of the physicians that comparatively little can be accomplished by these alone. Such printed circulars are often treated by the tenement-house mother very much as most of us treat the printed advertisements which are left at our doors—seldom read and soon thrown away. Mothers are often anxious and willing, but ignorant and stupid. Many cannot read and many more have not the wit to apply in practice what they read. When, however, such printed advice was preceded or accompanied by personal explanation, it was found of great assistance. Personal contact is the only sure way to influence these people, and this must be frequently repeated to influence them permanently; as an aid to this, printed slips are useful. Printed directions, however, should be as simple as possible in statement, few in number, and touch only the most vital matters, telling the mother always what she is to do, not what she is not to do.

Summary.—1. During hot weather when the resistance of the infants is lowered, the kind of milk taken influences both the amount of illness and the mortality; those who take condensed milk and cheap store milk do the worst, and those who receive breast milk, pure bottled milk, and modified milk do the best. The effect of bacterial contamination is very marked when the milk is taken without previous heating; but, unless the contamination is very excessive, it is only slight when heating was employed shortly before feeding.

2. The number of bacteria which may accumulate before milk becomes noticeably harmful to the average infant in summer, differs with the nature of the bacteria present, the age of the milk, and the temperature at which it has been kept. When milk is taken raw, the fewer the bacteria present the better are the results. Of the usual varieties, over 500,000 bacteria per c.c. are frequently deleterious to the average infant. However, many infants take such milk without apparently harmful results. Heat above 170° F. (77° C.) not only destroys most of the bacteria present, but, apparently, some of their poisonous products. No harm from the bacteria previously existing in recently heated milk was noticed in these observations unless they had amounted to millions, but in such numbers they were decidedly deleterious.

3. When milk of average bacterial quality was fed sterilized and raw,

those infants who received milk previously heated did, on the average, much better in warm weather than those who received it raw. The difference was so quickly manifest and so marked that there could be no mistaking the meaning of the results. The bacterial content of the milk used in the test was somewhat less than in the average milk of the city.

4. No special varieties ot bacteria were found in unheated milk which seemed to have any special importance in relation to the summer diarrheas of children.

5. After the first twelve months of life, infants are less and less affected by the bacteria in milk derived from healthy cattle. According to these observations, when the milk had been kept cool the bacteria did not appear to injure the children over three years of age, at any season of the year, unless in very great excess.

6. Everything possible should be done by Health Boards to improve the character of the general milk supply of cities by enforcing proper legal restrictions regarding its transportation, delivery, and sale. The general practice of heating milk is undoubtedly a large factor in the lessened infant mortality during the hot months.

7. Of the methods of feeding now in vogue that by milk from central distributing stations unquestionably possesses the most advantages, in that it secures some constant oversight of the child, and since it furnishes the food in such a form that it leaves the mother least to do, it gives her the smallest opportunity of going wrong. This method of feeding is one which might wisely be undertaken by municipalities.

8. Since what is needed most is intelligent care, all possible means should be employed to educate mothers and those caring for infants in proper methods of doing this. This, it is believed, can most effectively be done by the visits of properly qualified trained nurses or women physicians to the homes, supplemented by the use of printed directions.

9. While it is true that the results with the best bottle-feeding are nearly as good as average breast-feeding, it is also true that most of the bottle-feeding is at present badly done, so that as a rule the immense superiority of breast-feeding obtains. This should, therefore, be encouraged by every means, and not discontinued without good and sufficient reasons. The time and money required for artificial feeding if expended by the tenement mother to secure better food and more rest for herself, would often enable her to continue nursing with advantage to her child.

10. The injurious effects of table food to infants under a year old, and of fruits to all infants and young children in cities, in hot weather, should be much more generally appreciated.

MEANS THAT CAN BE EMPLOYED TO MAKE THE MILK SUPPLY SAFE AND OF FULL FOOD VALUE.

1. The prevention of adulteration, either by the addition of water, the removal of fats, or both, and the exclusion of all preservatives and, in fact, all foreign substances.

The detection of adulteration requires that samples be taken and tested in a chemical laboratory.

For Adulterations.—The principal adulterations of milk are effected by removing some of the cream or by adding water. Either of these procedures naturally results in a reduction of the percentage of the fats and other solids in the milk. Preservatives are sometimes added to prevent souring or rotting.

There are two general methods for the detection and determination of lowered fats and other solids, *viz.*, the gravimetric, or weighing method, and the mechanical method.

The Gravimetric Method for Fats.—A definite quantity (5 grams for instance) is accurately weighed. It is then absorbed by a roll of fat free paper, and dried at not over 100° C., to remove all water. The roll then contains all the milk solids. It is next placed in an apparatus known as an extractor and there is washed with ether until all the fat has been exhausted from the paper and is in the ether. The ether is now evaporated, and the fats obtained weighed.

The Gravimetric Method for Total Solids.—A definite quantity is weighed out, as described, in a small dish (lead, platinum, porcelain or glass), the weight of which is known, and is evaporated in a steam-heated oven to dryness. The weight in excess of the known weight of the dish is, of course, due to the milk solids.

By subtracting the weight of the fats from the weight of the total solids we obtain the total solids other than fat, which, of course, represents the proteins, the sugar, and the mineral matters.

The Mechanical Method for Fats.—A definite quantity of milk (17.4 c.c., about 18 grams) is measured into a graduated bottle, known as a Babcock flask, and 17.5 c.c. of strong sulphuric acid (90 per cent.) is added. The acid destroys the proteins, which allows the fat to rapidly collect in the graduated neck of the flask, when the latter is centrifuged. This happens because the fat is the lightest portion of the milk, and the heavier matters drive to the bottom of the flask, when it is whirled around. The long neck of the flask is so graduated that the percentage of fats can be read off directly. This method is accurate within two-tenths of 1 per cent., often nearer.

The Mechanical Method for Total Solids.—The specific gravity of the milk is obtained with a lactometer (a graduated instrument which floats higher or lower in accordance as the density—weight of a given volume—of the milk varies). From this figure, and the percentage of fats, previously obtained, the total milk solids can be calculated and the results correspond fairly closely with results obtained by the more accurate gravimetric method.

Preservatives.—Formaldehyde, or borax, or boric acid is sometimes used.

Formaldehyde may be detected by the violet ring that develops when a few drops of milk are carefully deposited upon the surface of a small quantity of sulphuric acid, containing iron, in a test-tube.

Boric acid, or borax, may be detected by the following procedure:

A piece of absorbent paper (filter paper) which has been colored brown (by soaking with a solution of a substance known as turmeric) is wet with some of the suspected milk. The paper is then dried and a little weak ammonia dropped on it. If either borax or boric acid is present the brown color of the paper turns green. There are also other tests in use.

2. The production of a clean milk, a milk low in bacteria, involving great care from the time of milking to actual consumption. This involves effort to insure the cleanliness of the cows and the milkers, properly constructed, clean barns, proper and thoroughly cleansed, vessels and utensils which the milk comes in contact with, exclusion of dust at every stage, immediate reduction of temperature after milking thorough icing during transportation, the sale under sanitary conditions in stores, and finally, proper care in the hands of the consumer.

FIG. 47.—Country inspector's outfit.

Testing Milk in the Bacteriological Laboratory.—The first requisite for the bacteriological examination of milk is that all materials used by the sanitary inspectors, or the laboratory force of the Department of Health, for handling samples be sterile, *i. e.*, free from bacteria. Sterility of these materials is essential, in order that the final result of the bacteriological examination may be strictly indicative of the number of bacteria per unit of the milk sample examined.

In the picture is a round can filled with small screw-cap bottles. This can with a tin cover which fits tightly, is used by the Department of Health inspectors in sending samples of milk from the country to the laboratory in the city. The complete country inspector's outfit is shown pictured here, prior to being mailed to its destination. Just as

soon as the samples have been taken, they are placed in the can, the can is packed in ice and reaches the city by express or milk freight within a few hours.

Similar bottles are used by inspectors in the city, but are carried about in a hand-grip which has a special compartment for cracked ice. It is necessary to keep the samples very cold, for, just as soon as the temperature of the milk reaches 50° F., the bacteria present begin to increase.

When the samples reach the laboratory their temperature is taken and recorded; carelessness in the icing of samples thus being detected, if it should ever occur; and they are tested at once. The object of the test is to determine how many living bacteria are present in one cubic centimeter of the sample. This is done by the so-called "plate method." The plate or "Petri dish" consists of two glass halves, the top fitting well over the bottom. These, after being well cleaned, are heated to a temperature of 200° C., in a hot-air oven, for one hour, and are thereby rendered dry and free from all living bacteria. The plates, ready for use, may be seen along the front edge of the table in the illustration.

FIG. 48.—A photograph of the bacteriological milk laboratory of the New York City Health Department. The samples of milk are being plated.

Undiluted milk is too opaque to be tested by the plate method—water is therefore added to the samples. The water used for the dilutions is first rendered free of living bacteria by heating at the boiling-point for one hour. Some, ready for use, appears in the illustration, contained in the square bottles with the metal tops, standing in front of the Petri dishes on the table.

The degree to which the milk under examination is diluted depends upon the grade of the milk being tested. A poor grade of milk will usually have a greater number of bacteria present than a good grade, and therefore the sample is diluted to a greater degree in order to facilitate the counting, as explained in the following:

The milk sample is shaken vigorously twenty-five times in order to break up all clumps of bacteria and to mix them thoroughly with the milk. If the sample is of pasteurized milk, a one in one hundred dilution is made by adding one part of milk to ninety-nine parts of sterile water, and the mixture is shaken vigorously twenty-five times. If the sample is of raw milk, two dilutions are made, a one in one hundred dilution as described above and, also, a one in ten thousand dilution, which is made by adding one part of the one in one hundred dilution to ninety-nine parts of sterile water and shaking the mixture twenty-five times.

One cubic centimeter of each dilution of milk is placed in a sterile Petri dish. A nutrient fluid, termed beef-extract-agar[1] is added to the plate at a temperature of 104° F. and thoroughly mixed with the diluted milk. The mixture hardens in the same manner as gelatine when cold,

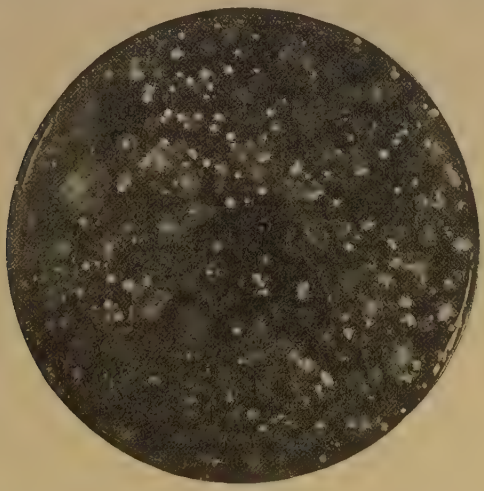

FIG. 49.—Photograph of a large number of colonies developing in a layer of nutrient agar contained in a small Petri dish. Some colonies are only pin-point in size; some as large as the end of a pencil. The colonies here appear in their actual size. (Park and Williams.)

but with the advantage that it does not liquefy in hot weather. The plates are later packed in a dark compartment (an incubator) where the temperature is constantly maintained at 37.5° C. (body temperature). After forty-eight hours the plates are taken out and examined. It will be found that wherever a bacterium lodged at the time the plate was made there is now a small spot visible—usually white, but occasionally pigmented. Although each spot represents an aggregation of many hundreds of thousands of bacteria, all in it grew from a single living organism, or a tiny clump of organisms, that was present in the sample tested, and which was separated from other bacteria by the diluting

[1] Agar, or agar-agar, is prepared from a sea weed found extensively along the shores of the Japanese Islands.

and shaking which is part of the routine. It is a simple matter to count these spots—technically known as "colonies"—and to multiply the total number on the plate by the dilution of the sample. For instance, if a plate made from one cubic centimeter of a one in one hundred dilution, contains two hundred and fifty colonies, we record the result as two hundred and fifty times one hundred, or twenty-five thousand bacteria per cubic centimeter of the sample tested. The result gives the total number of bacteria per unit (cubic centimeter) of milk, and this is an important gauge of its purity and suitability for use as food. (See the table of the various grades of milk, and note the maximum number of bacteria that each may contain.) The bacteriological examination does not reveal the identity of disease producing bacteria. To identify these would require an immense amount of work. Suspicion is aroused by cases occurring in some especial delivery route or in the distribution area of a special dealer. The city depends upon sanitary control and pasteurization to prevent the spread of infectious disease germs.

3. The production of a milk free from pathogenic organisms, requiring first of all healthy animals, and subsequently, the careful handling of the milk at all stages to prevent the introduction of the germs of infectious disease through human agencies, flies and dust.

FIG. 50.—Taking samples for bacteriological and chemical tests from cans just taken from the train.

Methods of Public Sanitary Control of the Milk Supply.—The general outlines of the methods adopted by boards of health and other governmental authorities in controlling the sanitary quality of milk supplies of towns and cities are fairly well defined. It is recognized that a system of inspections of dairies where the milk is actually produced, supplemented by inspections of creameries and of pasteurization plants, and of the methods of shipment and handling all the way from the farmer to the consumer, are necessary elements. Such inspection must

provide for the detection of contagious diseases among those handling the milk, as well as for the improvement of sanitary conditions.

Whether these details are carried out under the supervision of municipal or States authorities is a matter of expediency largely governed by local conditions. In practice, some of our large cities have found it necessary, in the absence of thorough-going State control, to develop their own system of milk inspection in the country as well as in the city.

The control of conditions under which milk is handled and sold within the city includes the regular inspection of stores and wagons, with frequent chemical and bacteriological tests and the usual method of enforcing sanitary requirements by resort to the courts if necessary.

More particular reference to the present system of milk inspection by the Department of Health of New York City and of the methods now in use will perhaps illustrate certain phases of the general subject.

Milk inspection began in New York in the late 70's and this inspection work was conducted in coöperation with the State officials of New York and New Jersey. Then, however, the elementary forms of adulteration, consisting in the removal of cream and the addition of water, were the only points considered. Later, it developed that a knowledge of the bacteriological content of milk was of much greater importance so far as the public health was concerned than was its chemical composition.

Legal Aspects of the New York Plan.—It was under the administration of Dr. Darlington, that inspection of milk in the country districts was first established and under Health Commissioner Lederle that grading and pasteurization was added. The Sanitary Code requires that no milk shall be sold in the City of New York without a permit from the Board of Health, and the board maintains that it is entitled to ascertain the conditions under which milk is produced before issuing a permit to the dealer who buys that particular milk and brings it to the city. Under the operation of this system, it is rare that permission to inspect a dairy or creamery is refused. When such refusal is met with the department notifies the dealer who then faces the alternative of refusing to receive milk from the particular farm or creamery under criticism or of having his permit to sell milk in the city revoked. The result, of course, is very salutary in excluding from New York City all milk from farms which are known not to meet the requirements. The question may be raised as to what protection other communities receive under this plan, since the producers whose milk is excluded from New York City doubtless find a market elsewhere. This exhibits the great defect of local control of milk supplies. It is undoubtedly far better that the State should undertake the control of milk production under adequate and uniform standards rigidly enforced throughout the State by a sufficient number of inspectors. Even if State supervision in New York were sufficient, a similar question remains in the case of the six other States from which the city's milk is drawn. With these varying jurisdictions, the city has been obliged to face actual conditions instead of legal or constitutional theories and evolve its own system of supervising the milk at every stage from the dairy to the breakfast table.

The various qualities of milk allowed to be placed on sale the Department of Health enforces in connection with the

REGULATIONS GOVERNING THE GRADES AND DESIGNATION NEW YORK. THE FOLLOWING CLASSIFICATIONS APPLY BACTERIAL CONTENT AND TIME OF

Grades of milk or cream which may be sold in the city of New York.	Definition.	Tuberculin test and physical condition.	Bacterial contents.
Grade A: milk or cream (raw)	Grade A milk or cream (raw) is milk or cream produced and handled in accordance with the minimum requirements, rules and regulations as herein set forth	(1) Only such cows shall be admitted to the herd as have not reacted to a diagnostic injection of tuberculin and are in good physical condition; (2) all cows shall be tested annually with tuberculin and all reacting animals shall be excluded from the herd	Grade A milk (raw) shall not contain more than 60,000 bacteria per c.c. and cream more than 300,000 bacteria per c.c. when delivered to the consumer or at any time prior to such delivery
Milk or cream (pasteurized)	Grade A milk or cream (pasteurized) is milk or cream handled and sold by dealers holding permits therefor from the Board of Health, and produced and handled in accordance with the requirements, rules and regulations as herein set forth	No tuberculin test required but cows must be healthy as disclosed by physical examination made annually	Grade A milk (pasteurized) shall not contain more than 30,000 bacteria per c.c. and cream (pasteurized) more than 150,000 bacteria per c.c. when delivered to the consumer or at any time after pasteurization and prior to such delivery; no milk supply averaging more than 200,000 bacteria per c.c. shall be pasteurized for sale under this designation
Grade B: milk or cream (pasteurized)	Grade B milk or cream (pasteurized) is milk or cream produced and handled in accordance with the minimum requirements, rules and regulations herein set forth and which has been pasteurized in accordance with the requirements and rules and regulations of the Department of Health for pasteurization	No tuberculin test required but cows must be healthy as disclosed by physical examination made annually	No milk under this grade shall contain more than 100,000 bacteria per c.c. and no cream shall contain more than 500,000 bacteria per c.c. when delivered to the consumer or at any time after pasteurization and prior to such delivery; no milk supply averaging more than 1,500,000 bacteria per c.c. shall be pasteurized in this city for sale under this designation; no milk supply averaging more than 300,000 bacteria per c.c. shall be pasteurized outside of this city for sale under this designation
Grade C: milk or cream (pasteurized) (for cooking and manufacturing purposes only)	Grade C milk or cream is milk or cream not conforming to the requirements of any of the subdivisions of Grade A or Grade B and which has been pasteurized according to the requirements and rules and regulations of the Board of Health or boiled for at least two (2) minutes	No tuberculin test required but cows must be healthy as disclosed by physical examination made annually	No milk of this grade shall contain more than 300,000 bacteria per c.c. and no cream of this grade shall contain more than 1,500,000 bacteria per c.c. after pasteurization

NOTE.—Sour milk, buttermilk, sour cream, kumyss, matzoon, zoolac and similar "Grade B" and shall be pasteurized before being put through the process of souring. No other words than those designated herein shall appear on the label of any container authorized under State laws.

have been divided into three kinds and the regulations which production of these grades are given in the following table:

OF MILK AND CREAM WHICH MAY BE SOLD IN THE CITY OF TO MILK AND CREAM. THE REGULATIONS REGARDING DELIVERY DO NOT APPLY TO SOUR CREAM.

Necessary scores for dairies producing—100 per cent. possible.	Time of delivery.	Bottling.	Labeling.	Pasteurization.
Equipment, 25 Methods, 50 Total, 75	Shall be delivered within thirty-six hours after production	Unless otherwise specified in the permit this milk or cream shall be delivered to the consumer only in bottles	Outer caps of bottles shall be white and shall contain the words Grade A raw, in black letters in large type, and shall state the name and address of the dealer.	
Equipment, 25 Methods, 43 Total, 68	Shall be delivered within thirty-six hours after pasteurization	Unless otherwise specified in the permit this milk or cream shall be delivered to the consumer only in bottles	Outer caps of bottles shall be white and shall contain the words Grade A in black letters in large type, date and hours between which pasteurization was completed; place where pasteurization was performed; name of the person, firm or corporation offering for sale, selling or delivering same	Only such milk or cream shall be regarded as pasteurized as has been subjected to a temperature of 142–145° F. for not less than thirty minutes.
Equipment, 20 Methods, 35 Total, 55	Milk shall be delivered within thirty-six hours and cream within forty-eight hours after pasteurization	May be delivered in cans or bottles	Outer caps of bottles containing milk and tags affixed to cans containing milk or cream shall be white and marked "Grade B" in bright green letters in large type, date pasteurization was completed, place where pasteurization was performed, name of the person, firm or corporation offering for sale, selling or delivering same; bottles containing cream shall be labeled with caps marked "Grade B" in bright green letters, in large type and shall give the place and date of bottling and shall give the name of person, firm or corporation offering for sale, selling or delivering same	Only such milk or cream shall be regarded as pasteurized as has been subjected to a temperature of 142–145° F. for not less than thirty minutes.
Score 40	Shall be delivered within forty-eight hours after pasteurization	May be delivered in cans only	Tags affixed to cans shall be white and shall be marked in red with the words "Grade C" in large type and "for cooking" in plainly visible type, and cans shall have properly sealed metal collars, painted red on necks	Only such milk or cream shall be regarded as pasteurized as has been subjected to a temperature of 142–145° F. for not less than thirty minutes.

products shall not be made from any milk of a less grade than that designated for
Sour cream shall not contain a less percentage of fats than that designated for cream.
containing milk or cream or milk or cream products except the word "certified" when

As may be well imagined, the attempt of New York City to exercise authority over the milk production of other States was not allowed to go unchallenged and the whole question was carried through the courts in appeal after appeal until finally the Supreme Court of the United States in a unanimous opinion affirmed that the position of the City of New York was reasonable, valid and not unconstitutional. In its decision the Supreme Court stated that any State has a right by reason of regulations to protect the public health and safety and that the Supreme Court "will not interfere because the States have seen fit to give administrative discretion to local boards to grant or withhold licenses or permits to carry on trades or occupations, or perform acts which are properly the subject of regulation in the exercise of the reserved power of the State to protect the health and safety of its people." Here then we have the support of the highest court in the land behind the effort to procure proper sanitary control of our local milk supply.

It is now a well-known fact that the general milk supply of every large city in the world is unfit for use in infant feeding. Two well-defined methods have been applied in New York to affect a change in this respect; first, the production of a special grade of milk, "certified" and allied grades, for infants, and, secondly, the general movement to improve the whole supply. Each of these methods has been successful to only a very limited extent. After twenty years less than 1 per cent. of the city's milk is of the certified type or equivalent thereto and the expense of this class of milk is almost prohibitive for general use in infant feeding. In fact, it is a luxury within reach of comparatively few. What is needed is a safe milk which can be furnished at a price within the means of the masses.

Mechanical Milker.—On account of the scarcity of labor the mechanical milker has become extensively employed. There is no objection to its use if the parts are kept scrupulously clean.

The attempt to bring the general market milk to the degree of purity required for infant feeding can never be successful in a large city. In the first place it is economically not feasible since too great a part of the total supply of milk is used for other purposes, for adults who do not require a milk of such special requirements and for cooking purposes where a still less degree of bacteriological cleanliness is necessary. It naturally follows that milk for the last two mentioned purposes can be produced and sold at lower prices than the special infant's milk. In the second place, although the system of surveillance has materially lessened the danger of infection of milk from the presence of cases of infectious diseases among the employees on the farms and in the creameries or from unhealthy animals, our present knowledge of the propagation of typhoid fever by milk infected by "typhoid carriers," and the fact that tuberculosis is so widespread among our dairy herds, have forced us to the conclusion that no matter how complete or well organized the system of dairy inspection, it will not be possible to render entirely safe the ordinary commercial milk which is produced and shipped to a city.

Dirt Testers.—The amount of insoluble dirt can be tested by filtering a pint of milk through cotton disks placed at the lower opening.

FIG. 51.—Mechanical milker, a great labor saving device, but a very difficult apparatus to keep clean on account of the valves and tubes.

FIG. 52.—Dirt tester, placed over an empty milk can, in operation.

The only way in which the sanitary authorities can meet these conditions is by requiring the pasteurization at least of all milk that is not of the highest grade.

FIG. 53.—Disks of cotton removed from dirt tester showing dirt removed from one pint of milk obtained from different sources.

Early in 1902 the Board of Health of the City of New York officially adopted a plan for grading milk according to its sanitary quality. The New York Committee on Milk Standards helped the general adoption of grading throughout the country.

Advantages of Grading for the Farmer.—It means in effect that farms will be scored, and a farmer will know what grade of milk he is producing and how he can produce a better grade if he so desires. The better grades of milk will command a higher price at the farm; therefore, for the first time in the history of milk production, an incentive will be given the farmer to produce a cleaner milk. This principle, of course, was established on a very small scale in the production of certified milk, but never before in production of milk for the masses.

For the Dealer.—The grading and proper labeling regulations will be a great incentive to the progressive and honest dealer who is willing and anxious to sell his products on a proper basis, and who by this plan will be aided in his efforts by official control. It will no longer be possible for the dishonest dealer to market the lowest grade of milk under false representations or to sell cooking milk for infants.

For the Public.—The users of milk will be enabled to purchase the quality of milk they require and for which they can afford to pay. This is particularly important in the case of milk for infants and children.

Certified Milk.—Most large cities now provide for infants a special milk which has not only the city's supervision but also that of a private commission. This milk, called "certified milk," is produced under the best attainable conditions. Suitable buildings, healthy tuberculin-tested cattle, healthy men, sterile utensils, the utmost cleanliness and many other requirements are insisted upon and made certain of by frequent inspections and milk examinations. This milk is practically a safe infant milk, although even this milk is liable through accident to possible contamination. This milk is generally produced under the auspices of a Medical Milk Commission. Since Dr. Coit brought together the first Commission, many others have been started. The Health Department of New York City has always coöperated with

the New York Milk Commissions. Certified milk belongs to Grade A raw. The State Agricultural Departments usually aid in making the tuberculin tests and in paying for the slaughtered reacting cattle.

The requirements for production by the New York County Milk Commission are as follows:

A maximum of 10,000 germs as an average per cubic centimeter of milk. This standard must be attained solely by measures directed toward scrupulous cleanliness, proper cooling and prompt delivery.

The milk certified by the Commission must contain not less than 4 per cent. of butter fat on the average, and have all other characteristics of pure, wholesome milk.

Milk must not be sold as certified beyond the day on which it reaches New York City. No milk may be shipped as certified which will reach the City more than thirty-six hours after production.

The sealed cap, authorized by the Commission, must be used on all the certified milk passing through the hands of dealers selling milk other than the certified. These caps are sent by the makers only to the farm where the milk is bottled.

The name of the farm from which the milk comes must appear on both the paper cap and the sealed cap.

Each bottle of milk must be dated on the date of bottling, or date to be sold.

The Milk Commission looks to the dealers for its fee.

Each dealer is expected to send a bottle of milk each week to the laboratory, taken at random from the day's supply for examination by experts for the Commission. Any dealer shipping to more than one town or city must supply weekly from each town.

The dealers are to furnish deep, covered boxes for certified milk.

The required conditions are as follows:

1. The Barnyard.—The barnyard should be free from manure and well drained, so that it may not harbor stagnant water. The manure which collects each day should not be piled close to the barn, but should be taken several hundred feet away. If these rules are observed, not only will the barnyard be free from objectionable smell, which is an injury to the milk, but the number of flies in summer will be considerably diminished.

These flies are an element of danger, for they are fond of both filth and milk, and are liable to get into the milk after having soiled their bodies and legs in recently visited filth, thus carrying it into the milk.

Flies also irritate cows, and by making them nervous reduce the amount of their milk.

2. The Stable.—In the stable the principles of cleanliness must be strictly observed. The room in which the cows are milked should have no storage loft above it; where this is not feasible the floor of the loft should be tight, to prevent the sifting of dust into the stable beneath.

The stables should be well ventilated, lighted and drained, and should have tight floors, preferably of cement, never of dirt.

They should be whitewashed inside at least twice a year, unless the

walls are painted or of smooth cement finish which can be washed frequently.

The air should always be fresh and without bad odor Sufficient light should be provided to enable the necessary work to be properly done during the dark hours. The manure should be removed twice daily, except when the cows are outside in the fields the entire time between the morning and afternoon milkings. The manure gutter must be kept in a sanitary condition. All sweeping of dry floors must be completed before grooming of cows is begun. All sweeping must be completed before the last washing of udders is begun.

There should be an adequate supply of water, warm and cold, and the necessary wash-basins, soap and towels.

3. Water Supply.—The whole premises used for dairy purposes, as well as the barn, must have a supply of water absolutely free from any danger of pollution with animal matter and sufficiently abundant for all purposes and easy of access.

4. The Cows.—No cows will be allowed in the herd furnishing certified milk except those which have successfully passed a tuberculin test. All must be tested at least once a year, by a veterinarian approved by the Milk Commission. All tuberculin tests must be arranged through the Milk Commission, or with the approval of the Milk Commission, and must be so planned that the representative of the Milk Commission may be present throughout, and be accommodated at or near the farm, in the same way as the doctor who makes the test, if the Commission so desires.

The farmer for whom the test is made must make sure that a chart of each test is furnished to the Milk Commission to keep on file within a week after the test, whether it be a private or State test. The Milk Commission reserves the right to decide what cows shall be kept in the herd.

No test will be regarded as satisfactory to the Milk Commission, unless four initial temperatures two hours apart are taken, and the temperatures begun after injection at the sixth hour and continued every two hours through the twenty-fourth hour after injection.

Any animal suspected of being in bad health must be promptly removed from the herd and her milk rejected. No cow whose udder is imperfect shall be allowed in the certified herd, nor shall the milk from an udder in any way diseased be put in the certified milk, as long as any disease exists. Cows must not be excited by hard driving, abuse, loud talking nor any unnecessary disturbance.

Feed.—No strongly flavored food, like garlic, should be allowed where cows can eat it.

When ensilage is fed, it must be given in one feeding daily, and that after the morning milking only, unless permission to feed half at night be given on the condition that all remaining be swept out of the barn before barn is closed for the night. The full ration of ensilage shall consist of not more than 20 pounds daily for the cow of average size. When fed in the Fall small amounts must be given and the increase to full ration must be gradual.

Corn stalks must not be fed until after the corn has blossomed, and the first feedings must be in small amounts and the increase must be gradual.

If fed otherwise, ensilage and corn stalks are liable to cause the milk to affect children seriously.

Cleaning.—The entire body of the cow must be groomed daily. Before each milking, the udder should be washed with a cloth used only for the udders, and wiped with a clean, dry towel. The udder must never be left wet, and the water and towel used must be clean.

The body of cow, from the shoulders back, should be dampened with clean water, and brush or towel used for that purpose. The tail should be kept clean by frequent washing, and like the body, should be dampened before each milking.

If the hair on flanks, tail, and udder is clipped close, and the brush on tail cut short, it will be much easier to keep cow clean.

The cows must all be kept standing after cleaning until the milking is finished. This may be done by a chain or a rope under the necks.

5. The Milkers.—The milker must be personally clean. He should neither have nor come in contact with any contagious disease while employed in handling the milk. In case of any illness in the person or family of any employe in the dairy, such employe must absent himself from the dairy until a physician certifies that it is safe for him to return.

A specimen of blood will be taken from each person connected with handling the milk and examined for typhoid. No person who has had typhoid, or reacts to the Widal test will be allowed to do any work in connection with the production of certified milk.

In order that the Milk Commission may be informed as to the health of the employes at the certified farms, the Commission has had postal cards printed, to be supplied to the farms, and to be filled out and returned each week, by the owner, manager, or physician of the farm, certifying that none are handling the milk who are in contact with any contagious disease.

Before milking, the hands should be washed in warm water, with soap and nail brush, and well dried with a clean towel. On no account should hands be wet during milking.

The milkers should have light colored, washable suits, including caps, and not less than two clean suits weekly. The garments should be kept in a clean place, protected from dust, when not in use.

Iron milking stools are recommended, and they should be kept clean.

Milkers should do their work quietly and at the same hour morning and evening.

Jerking the teat increases materially the bacterial contamination of the milk and should be forbidden.

6. Helpers Other Than Milkers.—All persons engaged in the stable and dairy should be reliable and intelligent. Children under twelve should not be allowed in the stable or dairy building during milking, since in their ignorance they may do harm, and from their

liability to contagious diseases, they are more apt than older people to transmit them through the milk.

7. Small Animals.—Cats and dogs must be excluded from the stables during the time of milking, and fowl at all times. No animals are allowed in the dairy.

8. The Milk.—All milk from cows sixty days before and ten days after calving must be rejected.

The first few streams from each teat should be discarded in order to free the milk ducts from the milk that has remained in them for some time and in which the bacteria are sure to have multiplied greatly. If any part of the milk is bloody or stringy or unnatural in appearance, the whole quantity yielded by that animal must be rejected. If any accident occurs in which a pail becomes dirty, or the milk in the pail becomes dirty, the pail should be put aside, and the milk must be discarded.

The milk from each cow should be removed from the stable immediately after it is obtained to a separate, clean room, and strained through a sterilized strainer of cheesecloth or cheesecloth and absorbent cotton.

The rapid cooling of the milk is a matter of great importance. The milk should be cooled to 45° F. within an hour and not allowed to rise above the temperature as long as it is in the hands of producer or dealer. In order to assist in the rapid cooling, the bottles should be cold before the milk is put into them.

Aëration of milk beyond that obtained in milking is unnecessary.

9. Utensils.—All utensils should be as simple in construction as possible, and so made that they may be thoroughly sterilized before each using.

Coolers, if used, should be sterilized in a closed sterilizer, unless a very high temperature can be obtained by steam sent through them.

Bottling machines should be made entirely of metal with no rubber about them, and should be sterilized in closed sterilizer before each milking or bottling.

If cans are used, all should have smoothly soldered joints, with no places to collect dirt.

Pails should have openings not exceeding 8 inches in diameter and may be either straight pails, or the usual shape with top protected by a hood.

Bottles should be of the kind known as "common sense," and capped with a sterilized paraffined paper disc, and the caps authorized by the Commission.

All dairy utensils, including the bottles, must be thoroughly cleansed and sterilized. This can be done by first rinsing in warm water, then washing with a brush and soap and other alkaline cleansing material and hot water, and thoroughly rinsing. After this cleansing they should be sterilized by boiling, or in a closed sterilizer with steam, and then kept inverted in a place free from dust.

10. The Dairy.—The room or rooms where the utensils are washed and sterilized and the milk bottled should be at a distance from the

house and the barn, so as to lessen the danger of transmitting through the milk any disease which may occur in the house.

The bottling room, where the milk is exposed, should be so situated that the doors may be entirely closed during the bottling and not opened to admit the milk nor to take out filled bottles.

The empty shipping cases should not be allowed to enter the bottling room nor should the washing of any utensils, except fixed cooler, be allowed in the room.

The workers in the dairy should wear white washable suits, including cap, when handling the milk.

Bottles must be capped with the sterilized discs as soon as possible after filling.

FIG. 54.—A steam sterilizer for a small plant.

11. EXAMINATION OF MILK AND DAIRY INSPECTION.—In order that the dealer and the Commission may be kept informed of the character of the milk, specimens taken at random will be examined weekly by experts for the Commission.

THE COMMISSION RESERVES THE RIGHT TO MAKE INSPECTIONS OF CERTIFIED FARMS AT ANY TIME AND TO TAKE SPECIMENS OF THE MILK FOR EXAMINATION AND TO IMPOSE FINES FOR REPEATED OR DELIBERATE VIOLATIONS OF THE REQUIREMENTS OF THE COMMISSION.

The Commission also reserves the right to change its standards in any reasonable manner upon due notice being given the dealers.

When we consider our inability to identify the chronic typhoid bacillus carrier, the slight cases of diphtheria and of scarlet fever, and the impossibility of eliminating in the near future tuberculosis from the dairy herds, we realize that something beyond inspections

is required to make safe the general milk supply. Most of us who have studied the question believe that proper pasteurization under rigid inspection is the method by which a safe wholesome milk supply can be provided.

Reasons for and Against Pasteurization.—Those who oppose pasteurization usually do so from one of two standpoints: Some feel that the heating of the milk improves its keeping qualities so much that the dairyman will cease to take any pains to provide a clean milk or care for its preservation. This is not an objection that serious people should give weight to. The milk problem is too important to allow difficulties which can readily be obviated to prevent us doing what is thought to be best. We know that dirty milk teeming with bacteria is not as wholesome after heating as fairly clean milk containing but moderate numbers of bacteria. Health authorities must insist on as sanitary conditions at the farms and creameries as they consider necessary to produce a wholesome milk supply. The average farmer does not now and probably never will take sufficient precautions to insure a safe milk.

The other objection is that pasteurization changes the milk chemically so that it is less suitable as a food. Here we must carefully separate the milk for infant feeding from that for older children and adults. So far as I know there is no serious claim that milk is injured for the latter by heating to 145° F. for twenty minutes. For infants there is a difference of opinion among experienced physicians. From personal knowledge, I can state that very few infants in New York City consume raw milk.

There is an opinion held by many intelligent persons that heating milk makes it more liable to infection and that the bacteria grow more rapidly in it than in its unheated state. This idea has developed from the fact that milk when drawn from the udder has slight bactericidal properties which cause a reduction during the first few hours of the bacteria in very clean milk. This power is, however, completely lost by the time the milk reaches the pasteurizing plant.

It is also true that if a few bacteria of a new variety are added to a milk containing only a few hundred bacteria per c.c. they will grow faster than if added to milk containing several millions. This is merely because the milk is already becoming overcrowded with microörganisms. When the bacterial growth became still more excessive there would be a still greater impediment to the growth of new additions. The following outcome of a test with five samples, which is an average result, shows the absurdity of thinking that the bacteria in the heated portion of a milk sample will be able to grow so rapidly as to outstrip the number in the unheated portion. Only after the raw milk has become sour will this become possible.

Temperature at Which Milk Should be Pasteurized.—Those who are cognizant of the literature concerning the heating of milk know that there has been much difference of opinion as to the temperature which should be used. There are many reasons for these different views. The

purpose for which the milk is to be pasteurized is not always the same. In one case it may be simply to prevent the milk souring at an early time. In another it is the destruction of some special variety of pathogenic bacteria, as in case of a typhoid infection, and in still a third, it is the destruction of tubercle bacilli, which are somewhat more resistant than other non-sporebearing pathogenic bacteria. Finally where milk is to be kept warm, it may be desirable to actually sterilize the milk.

	Sample 1.	Sample 2.	Sample 3.	Sample 4.	Sample 5.
Pure milk, original number bac.	2,340,000	1,440,000	5,400,000	118,000	1,020,000
Same after heating 160° F.: one-half min.	27,000	10,000	1,600	950	720
Same after heating for one min.	10,000	1,160	900	450	260
	Kept 24 hours at 48° F.				
Unheated	8,100,000	10,800,000	7,560,000	660,000	8,100,000
One-half min.	32,400	12,400	6,000	1,680	1,750
One min.	16,500	3,400	5,000	1,000	1,040
	Kept 48 hours at 48° F.				
Unheated	27,000,000	32,400,000			
One-half min.	51,000	15,500			
One min.	30,000	17,000			
	Kept 5 hours at 72° F.				
Unheated	54,000,000	90,000,000			
One-half min.	372,000	116,000			
One min.	180,000	120,000			
	Kept 24 hours at 72° F.				
Unheated	163,000,000	324,000,000	108,000,000	118,000,000	112,000,000
One-half min.	18,900,000	27,000,000	8,640,000	7,560,000	7,020,000
One min.	16,200,000	21,600,000	8,100,000	5,400,000	5,400,000

A study of the figures shows that in the ice-chest there is a less increase in the heated than in the raw milk. At much higher temperatures there is a greater development, but here it is because the bacteria are approaching the limit of their growth and are being injured by the acids and other bacterial products produced. One objection is true. Pasteurized milk because most of the lactic acid bacteria have been killed, will not as quickly sour from bacterial growth. If this were really a serious objection it would be a very simple matter to add to the heated milk a few harmless lactose fermenting bacteria.

The methods by which the tests of efficiency have been carried out have varied. In some the heat has been applied instantaneously, in others it has taken several minutes for it to reach the maximum temperature. Still again, early workers were sometimes deceived as to the results in tests with tubercle bacilli. Tubercle bacilli when dead are now known to poison the tissue cells lying adjacent to them and to give lesions showing microscopical appearances similar to those excited by living bacilli; when many are injected in one place a small abscess may develop. The tissues in which the dead bacilli have lodged at the time of injection have thus simulated tuberculosis, and caused investigators to report falsely that they were not killed. At times the only way that the action of living bacilli can be separated

from dead bacilli is to reinoculate a second animal from the first doubtful one.

Considering the results from the investigations of others and of those made in the Research Laboratory of the Department of Health, the following temperatures may be considered sufficient to destroy all pathogenic bacteria apt to occur in milk. If we wish to insure the destruction of tubercle bacilli, milk heated at 80° C. for one minute, 75° for two minutes, 70° for three minutes, 65° for fifteen minutes, and 60° for twenty minutes, will contain no living tubercle bacilli, and necessarily no living typhoid, diphtheria or other non-sporebearing human pathogenic bacteria. If it is not necessary to destroy tubercle bacilli, those temperatures for one-half the above duration will suffice. In order to have the least chemical change in the milk, 60° C. (140° F.) for twenty minutes or 65° C. for fifteen minutes, are probably the best temperatures to be selected. 70° C. (158° F.) for three minutes is also a fairly suitable temperature, especially when the milk is to be used by others than infants, for the chemical changes which become somewhat greater with the higher temperatures, even for the shorter time, are not objectionable when the milk is for adults or older children.

The figures previously given, which show the destruction of bacteria when the milk has been heated for thirty seconds at 60° C., may seem to many to show a very surprisingly high death-rate of the bacteria, because the samples of commercially pasteurized milk taken from various places and said to be equally heated usually show very much less bacterial destruction. It is the practice, however, of commercial firms to state that the milk has been heated for a certain number of seconds to a certain degree, when, as a matter of fact, the milk has only been heated for one or two seconds to the degree stated, the rest of the time being occupied in the process of heating and cooling. As a rule, also, these pasteurizers have no accurate method of determining and regulating the temperature, so that frequently the milk is not accurately heated even for a second to the degree stated. In some cases because of lack of cleanliness more bacteria are added to the milk after heating than were killed in the process. To a certain extent different milks will always vary in the percentage of destruction of their contained bacteria, taking place when they are heated, because of variation of the types of bacteria present in the milk. This, however, is only true to a very moderate degree. Commercial pasteurization should not be allowed to be carried on without careful supervision. There should be a requirement that all machines be subjected to tests by the health authorities, before they are allowed to be used. After it is in operation the inspectors should continue to observe and make sure the machines are properly run. All pasteurizers should have some apparatus which will automatically indicate the temperature to which milk is heated, the temperature at which it is cooled, and the rate of flow. The records should be at all times subject to examination.

Dry Milk.—This is prepared chiefly by two processes. In one the milk is dried while in a spray. In the other it dries as a film on hot

rollers. In the former process the albumins remain partially soluble. When prepared from milk of good quality dry milk has about the same value as pasteurized milk. The vitamins are partly destroyed by heating, and partly by long storing. It may be prepared from skimmed milk or from milk containing less than the normal fat-content. The use of dry milk is rapidly increasing.

FIG. 55.—Large pasteurization plant. Milk is heated, held in tanks at 140° F. for twenty minutes, cooled and collected into bottles. It is protected from contamination as it flows by gravity step by step.

The Bacteriological Examination of Milk.—The identification of pathogenic bacteria in milk is extremely difficult on account of the great numbers of saprophytic bacteria, which tend to over-grow the pathogenic bacteria on any of our culture media.

Tuberculosis is the only exception, and this is due to the fact that instead of media we use the animal to separate the tubercle bacilli from other bacteria. So far as diphtheria and typhoid bacilli, these are almost never obtained from milk; there are only a half-dozen instances in which this has been actually done. We should never depend, therefore, upon the bacteriological examinations for pointing

out where the danger of infection exists. We must depend upon the circumstantial evidence of persons acquiring the disease who consume the milk, and then in tracing up the original sources to the infected supply. The ordinary bacteriological examinations of milk are for the purpose of detecting the condition under which the milk was supplied. We know from long experience that the cleaner the milk is the fewer the bacteria that fall into it. We know that the cooler the milk is kept, the slower will be the development of the bacteria originally entering it.

The following table sets forth these facts very effectively:

Temperature.	Time which elapsed before making test.			
	24 hours.	48 hours.	96 hours.	168 hours.
21° F. (0° C.)	2,400	2,100	1,850	1,400
	30,000	27,000	24,000	19,000
39° F. (4° C.)	2,500	36,600	218,000	4,200,000
	38,000	56,000	4,300,000	33,000,000
42° F. (5.5° C.)	2,600	3,600	500,000	
	43,000	210,000	5,760,000	
46° F. (6° C.)	3,100	12,000	1,480,000	
	42,000	360,000	12,200,000	
50° F. (10° C.)	11,600	540,000		
	89,000	1,940,000		
55° F. (13° C.)	18,800	3,400,000		
	187,000	38,000,000		
60° F. (16° C.)	180,000	28,000,000		
	900,000	168,000,000		
68° F. (20° C.)	450,000	5,000,000,000		
	4,000,000	5,000,000,000		
86° F. (30° C.)	1,400,000,000			
	4,000,000,000			
94° F. (35° C.)	5,000,000,000			
	5,000,000,000			

The bacterial counts, therefore, indicate whether the milk was obtained in a cleanly way, and also whether it was kept cool, and to some extent as to whether it was quickly consumed. The bacterial count also shows the effectiveness of heating the milk. To a very slight extent the examination for certain types of bacteria such as the streptococcus has some importance as tending to detect a mastitis in the cows or other cattle infections, but in the usual city milk, which is a mixture of many supplies, very little can be determined from such examinations.

CHAPTER XIII.

BACTERIAL INFECTIONS AND PARASITIC DISEASES FROM MILK, MEAT AND OTHER FOODS.

By WILLIAM H. PARK, M.D.

PATHOGENIC BACTERIA IN MILK.

Tuberculosis, typhoid fever, scarlet fever, diphtheria and septic sore-throat are the chief diseases transmitted by means of milk in this locality. Poisoning from the toxin of Bacillus botulinus has occurred from cheese. In other countries cholera, Malta fever and possibly other diseases may be due at times to milk infection. The obscure disease trembles is also believed to be due to milk.

The tubercle bacilli in milk are in the majority of cases derived from the cow, but may come from human sources, the typhoid bacilli are entirely from man, the contagion of true scarlet fever conveyed in milk is probably always from man, but the contagion of a disease closely allied to it is certainly given off by cows, suffering from certain septic diseases as yet not fully identified. Diphtheria bacilli are probably always of human origin, as animals, except cats, practically never suffer from the disease and these only under exceptional conditions. The streptococci exciting septic tonsillitis are probably usually from cases of inflammation of the udder which in turn received their infection from man. As milk is usually kept below 60° F. the typhoid bacilli and the streptococci are the only germs that we believe increase in any appreciable extent.

The following epidemics and cases have been recorded in the bulletin of the Public Health Service, as produced by cow's milk:

	Epidemics.	Cases.
Typhoid fever	179	6900
Scarlet fever	51	2400
Sore-throat	7	1100
Diphtheria	23	960
Tuberculosis	4 per cent. of cases in children.	

While this is a very incomplete list, the figures probably give an accurate comparative statement as to the relative frequency of the different infections. The general introduction of pasteurization has almost eliminated milk infection in cities.

The cases of trembles (milk sickness), believed to be due to milk, have not been collected with sufficient care to be reported. No case of measles, small-pox, whooping-cough, or mumps has been clearly traced to milk.

The Relation of Bovine to Human Infection.—The opinions of those best able to decide this question have been subject to remarkable changes during the past twenty years. At first, in spite of the results of early investigations which indicated a difference in virulence, almost all considered that the bacilli from cattle were practically identical with those from man and could equally well produce human infection. All agreed that tuberculosis in cattle should be stamped out, so as to avoid human infection. Avian tuberculosis was then sharply differentiated from human, and a little later bacilli from bovine and human sources were shown by Theobald Smith to have certain biological differences as well as the earlier known differences in rabbit virulence. This made it necessary to test a large number of cultures from both man and cattle to determine to what degree the bovine type was transmitted to man and the human type to the cow, and if such transmission occurred how permanent were the differences in the types of bacilli. In 1901 Koch startled the medical profession with his opinion in the announcement that bovine infection of man was so rare that it was a negligible quantity in the fight against human tuberculosis.

COMBINED TABULATION CASES REPORTED AND OWN SERIES OF CASES.

Diagnosis.	Adults 16 years and over.		Children 5 to 16 years.		Children under 5 years.	
	H.	B.	H.	B.	H.	B.
Pulmonary tuberculosis	644	(1?)	11	—	23	1
Tuberculous adenitis, axillary or inguinal	2	—	4	—	2	—
Tuberculous adenitis, cervical	27	1	36	21	15	21
Abdominal tuberculosis	14	4	8	7	9	13
Generalized tuberculosis, alimentary origin	6	1	2	3	13	12
Generalized tuberculosis	29	—	4	1	43	5
Generalized tuberculosis including meninges, alimentary origin	—	—	1	—	3	8
Generalized tuberculosis including meninges	5	—	7	—	52	1
Tuberculous meningitis	1	—	3	—	27	4
Tuberculosis of bones and joints	27	1	38	3	26	—
Genito-urinary tuberculosis	17	1	2	—	—	—
Tuberculosis of skin	3	—	1	—	1	—
Miscellaneous cases:						
Tuberculosis of tonsils	—	—	—	1	—	—
Tuberculosis of mouth and cervical nodes	—	1	—	—	—	—
Tuberculous sinus or abscess	2	—	—	—	—	—
Sepsis, latent bacilli	—	—	—	—	1	—
Totals	777	10	117	36	215	65

Mixed or double infections, four cases. Total cases, 1,224.

This aroused great opposition and investigations were begun in England and Germany on a large scale. Ravenel isolated the first bovine bacillus in a child in America. Smith in a quiet way continued his careful investigation of a number of cases. A group of us in New York City have been studying the question at the Research Laboratory. As the work of the English and German Commissions and of Smith was devoted to selected cases and had succeeded in establishing the

presence of bovine infection in some of these, we decided to take every case occurring in several hospitals devoted to children and also several hundred cases of adult pulmonary tuberculosis, so as to be able to get an opinion as to the relative frequency of infection with each type of bacilli. Something over 1 per cent. of the total deaths from tuberculosis are due to bovine bacilli. In little children probably 10 per cent. of the total deaths are due to the bovine type. The percentage of tubercular glands in young children due to bovine bacilli is fully 30 per cent. In England the amount of infection due to the bovine type seems to be somewhat greater, while in Germany it may be a little less. We have found the sparse growth of early cultures of the bovine type as contrasted with the vigorous growth of the human type on glycerin egg to be the best cultural test for differentiating the two types. If we add the 450 cases studied by us to those of all other workers, we get the results in the table on the preceding page.

Taking the cases given in the total tabulation and combining the important diagnoses under one heading gives us the following table, which shows clearly the percentage incidence of bovine infection.

PERCENTAGE INCIDENCE OF BOVINE INFECTION.[1]

Diagnosis.	Adults 16 years and over, per cent.	Children 5 to 16 years, per cent.	Children under 5 years, per cent.
Pulmonary tuberculosis	0(?)[2]	0.0	4.1
Tuberculous adenitis, cervical	3.6	36.0	58.0
Abdominal tuberculosis	22.0	46.0	59.0
Generalized tuberculosis	2.7	40.0	23.0
Tubercular meningitis (with or without generalized lesions)	0.0	0.0	13.6
Tuberculosis of bones and joints	3.5	7.3	0.0

Caution is necessary in applying these figures, they tell nothing but the incidence; the seriousness of the infeciton is indicated in the revised table.

Under certain diagnoses a great many latent or slight infections are included, which may never have had any effect on the health of the child had not some intercurrent infection led to death. Furthermore, due to selection of material, the number of cases of generalized tuberculosis of alimentary origin is markedly out of proportion and bears no relation to the incidence of these cases in proportion to other types of disease. If we rearrange the figures under these headings leaving out all but severe types of disease and consider the selected cases of alimentary tuberculosis separately, the following table gives the results.

[1] Exclusive of cases of double infections. In considering pulmonary cases it must, however, be remembered that bovine tubercle bacilli have been isolated from the lung in cases of generalized tuberculosis in children.

The number of cases under some of the headings is too small to deduce percentages. Reference to the preceding table makes this evident.

[2] If the two bovine cases of the Royal Commission were included, the percentage would be 0.3. We have not included these two cases as the additional human cases could not be included. If we combine the pulmonary cases regardless of age we can then add these cases, giving us a total of 710, exclusive of the one doubtful case, Of these, 3 or 0.42 per cent. were bovine infections.

Only cases under sixteen years are considered, as we have only noted the severity of disease in these cases in the tables. The percentage of our cases are given for comparison.

PERCENTAGE OF BOVINE INFECTION. (*Revised.*)

Diagnosis.	Children 5 to 16 years.		Children under 5 years.	
	Combined figures, per cent.	Own figures, per cent.	Combined figures, per cent.	Own figures, per cent.
Abdominal tuberculosis	66	50	69	75
Generalized tuberculosis, alimentary origin	60	—	48	66
Generalized tuberculosis	20	—	11	18
Tubercular meningitis, secondary to tuberculosis of alimentary type	—	—	72	—
Tubercular meningitis (other than preceding)	—	—	6	5½

Revising the percentages in this way gives close agreement. The percentages are highest in the relatively less common types of tuberculosis. In the two types of tuberculosis, which mainly constitute the fatalities in young children, the percentages range from 5½ per cent. to 18 per cent. All things considered, we feel safe in saying that the percentage of deaths from bovine tuberculosis in young children, *viz.*, 6⅓ per cent. to 10 per cent. as deduced from our unselected cases in New York City, are applicable to most cities throughout the world whose milk supply is similar to ours and is not pasteurized.

A test carried out during the past three years shows a marked decrease in the amount of bovine infection of children. The only cases found had consumed raw milk.

Conclusions.—Bovine tuberculosis is practically a negligible factor in adults. It very rarely causes pulmonary tuberculosis or phthisis, which causes the vast majority of deaths from tuberculosis in man and is the type of disease responsible for the spread of the virus from man to man.

In children, however, the bovine type of tubercle bacillus in those consuming raw cows' milk causes a marked percentage of the cases of cervical adenitis leading to operation, temporary disablement, discomfort, and disfigurement. It causes a large percentage of the rarer types of alimentary tuberculosis requiring operative interference or causing the death of the child directly or as a contributing cause in other diseases.

In young children it becomes a menace to life and causes from 6⅓ to 10 per cent. of the total fatalities from this disease.

The Relation of the Typhoid Carrier to Milk Infection.—Many epidemics of typhoid fever have until recently puzzled investigators because, though evidently milk borne, yet no case of typhoid fever could be found. The discovery that about 2 per cent. of those who have recovered from typhoid fever remain infected and continue during the rest of their lives to pass typhoid bacilli, has cleared up the mystery. Epidemics due to these carriers have already been traced both in New

York City and elsewhere. Many observers have already discussed the relation of typhoid cases to milk infection. Hands, water, flies, etc., may all aid in the transfer of the bacilli from the dejecta to the milk. Some years ago we traced over four hundred cases to infection of a milk supply by a typhoid carrier who had the disease forty-seven years ago.

The Conveyance of Scarlet Fever by Means of Milk.—As we do not know the organism which excites scarlet fever, we are not as clear as to the means by which it is spread as we are in the case of tuberculosis, typhoid fever and diphtheria. We know, however, that the throat secretions are dangerous. Where the infection has been traced it has usually been found that the milker has suffered from an unrecognized case or is convalescent. It seems as if the contagion must either increase in milk or be capable of infecting when greatly diluted, for cases have developed from milk after great dilution.

Septic Sore-throat With or Without a Scarlatiniform Rash.—A number of epidemics have come from the milk of diseased cows. The etiology of the epidemic is discussed under the disease septic sore-throat. The history of a typical outbreak was as follows: The milk from a septic cow was delivered to two schools. About thirty of the boys who drank the milk developed the disease while none of the day scholars who went home to lunch did. Some of the cases developed at first only sore-throats, others only the rash. On the second day the cases resembled very closely scarlet fever. There was no scarlet fever in the town. The milk contained numbers of streptococci. In several outbreaks we have been able to obtain the same type of streptococcus in the throat of the milker, the udder of the cow and in the throats of the consumers who developed infection.

Diphtheria is occasionally produced by milk. The diphtheria bacilli usually originate from a mild case, the nature of which was overlooked or from a healthy carrier.

The Detection of Milk Epidemics.—Upon the quick discovery of the presence of infected milk will depend the limiting of the number of cases. It is important not only that all cases of typhoid fever, scarlet fever and diphtheria occurring on the farm be reported, but also that all cases in a city be investigated as to the milk supply.

1. The number of cases of the disease existing and of houses invaded in the involved territory, during the time covered by the epidemic.
2. The number of invaded houses supplied in whole or in part, directly or indirectly, by the suspected milk.
3. The total number of houses supplied with the suspected milk.
4. The relative proportion of houses so supplied to those supplied by other dairies.
5. The location of the case or cases from which the milk appeared to become contaminated and the means by which the infection reached the milk.
6. The time relation of the original case to the epidemic.

7. The special incidence of the disease among milk drinkers.
8. The elimination of other common carriers of infection.
9. The effect upon the epidemic of taking such measures as will eliminate the possibility of milk contamination.

TRANSMISSION OF PATHOGENIC BACTERIA TO MAN, THROUGH MEAT, FISH AND SHELL-FISH.

Human parasitic bacteria are not commonly found in meat, and still more rarely in fish. If present they are usually destroyed in the process of cooking. If any survive in complete cooking they must pass the ordeal of being subjected to the action of the gastric juice. The great majority of dead bacteria and of bacterial products are harmless when swallowed. Diphtheria and tetanus toxins and snake venoms are all harmless. The meat of diseased animals after cooking has been eaten numberless times without apparent injury, unless preformed heat-resistant toxins were present or infection of the meat occurred after cooking. It is, however, the general practice that the meat of animals which are sufficiently infected to be truly sick should not be eaten, and when the bacteria are of a kind like anthrax, which are capable of causing intestinal infection, that the meat should be destroyed. Under many conditions, when certain tissues only are involved and the others are sound, it is proper to consume the latter, as in tuberculosis. The general rule in this infection is to use the meat from cattle that have localized disease only. The same is true of the meat from hogs. Every part that contains tubercles should be removed. When an animal has general tuberculosis the whole carcass is destroyed. The bovine bacilli are dangerous only to infants and children. (See Milk Infection.)

Typhoid fever has rarely been traced to oysters, clams and mussels. The outbreak described by Professor Conn had twenty-three victims. We have traced several such outbreaks in the neighborhood of New York City. Paratyphoid, dysentery and ordinary diarrheas may also be caused by shell-fish. Some have apparently shown that oysters retain their infectivity for several weeks when placed in unpolluted water. In our tests the oysters when healthy free themselves of infection in a few days. Foote showed that oysters kept in storage might hold viable typhoid bacilli for a month.

POISONING BY MEAT AND FISH.

The infection may be a result of disease of the animal or it may be a postmortem contamination. The cases reported have almost always been in those persons who have eaten raw or imperfectly cooked meat. Animals suffering from septicemias and fatal diarrheas are liable to be infected with the paratyphoid or related bacilli.

In 1888 Gärtner isolated a bacillus from the suspected meat and obtained the same organism from a person that died in an outbreak. He named this the "Bacillus enteritidis."

Poisoning by Meat and Fish.—The use of partially decayed meat and fish was more frequently the cause of illness in the past than today. This type of food-poisoning usually exhibits the symptoms of an acute gastro-enteritis, the more severe cases showing systemic symptoms of poisoning. A fatal outcome is infrequent. The cases are more common in warm weather. Such poisonings have been attributed to the so-called "ptomains," substances derived from the protein of the meat due to the proteolytic activity of putrefactive bacteria. The food commonly shows evidences of spoilage, although in some instances it may be slight. It is claimed that the ingestion of foods contaminated with B. proteus will give rise to gastro-enteritis, although no spoilage is evident to the senses.

In most instances food-poisoning is due to the presence not of proteolytic products but of certain types of bacteria or their toxins, viz., bacilli of the paratyphoid enteritidis group or B. botulinus.

It is now know that the paratyphoid-enteritidis types B. enteritidis and B. choleræ suis, are encountered in the domestic food-producing animals. Both bacilli are met with in hogs, usually as secondary invaders in hog cholera. B. enteritidis is the usual type in cattle. If meat from infected animals is used for food, poisoning commonly results. Sound meat may be contaminated by contact with the meat of diseased animals. The likelihood of poisoning as well as the severity of the disease will depend on how and how long such meat is kept. If the bacilli have an opportunity to multiply freely and produce large amounts of toxin the meat will cause disease even though the bacilli be killed during cooking—that is, the toxin is heat resistant. In this connection it is well to remember that even though there be no preformed toxin, cooking could not be relied upon as a means of rendering infected meat safe for consumption, unless it be thorough, as bacilli might survive in the center of the meat. The type of disease depends on the relative proportion of preformed toxin. If much is present the disease is more acute. If viable bacilli are present they may not only cause an enteric infection but invade the blood stream, giving rise to a febrile disease of short duration. This type of food-poisoning has been most commonly reported from European countries. The following is a characteristic example:

An apparently healthy calf was slaughtered. Two days later a baker made 160 meat pies. Over 50 persons were made sick, and 4 of these died. These 4 ate pies which had been kept ten days or more. The outbreak was due to the Bacillus enteritidis, which was believed to have greatly multiplied during the two days' storage at a moderately warm temperature. All the cases presented similar symptoms. The chief of these were vomiting, diarrheas and shivering. In some cases collapse occurred. Pains in the abdomen and back were felt by many. The symptoms began in from five to fourteen hours after eating. Some cases of poisoning from fish are apparently due to protein susceptibility of those eating it.

Botulinus-poisoning has been associated not only with meat but also canned vegetables. It is discussed below.

Some cases of poisoning from fish are apparently due to protein susceptibility of those eating it, the fish itself being of excellent quality.

Botulism is due to the contamination of foods by the B. botulinus. This bacillus is not an infectious organism but produces a highly poisonous extracellular toxin in the food, which toxin differs from other similar toxins in that it is poisonous when taken by mouth. Botulism abroad has been most frequently due to contaminated ham, sausages and canned fish. In this country nearly all the cases have resulted from the use of canned vegetables and fruits, especially beans, asparagus and ripe olives. The disease is more common in the West. Home-canned vegetables have been most frequently involved. The bacillus is a spore-bearing anaërobe. If heating is insufficient the spores survive, germinate and then multiply in the absence of oxygen and produce the toxin. This takes time, and poisoning usually follows the consumption of foods which have been prepared for some time.

The foods thus contaminated show evidences of spoilage. The most characteristic change is the appearance of a rancid butter odor, although this may be overlooked. In the case of vegetables or olives the presence of a cloudy liquor should be considered highly suspicious.

The symptoms of poisoning generally appear in twenty-four to thirty-six hours after ingestion of the food. They consist of secretory disturbances and motor paralysis. The former is evidenced by suppression of the salivary secretion or the presence of an excessive mucous secretion. The latter is shown by eye symptoms, such as disturbances of accommodation and ptosis; difficulty in swallowing; aphonia; difficulty in breathing and obstinate constipation. Consciousness is unimpaired and death results from asphyxia due to respiratory paralysis. The disease is highly fatal and very little of the contaminated food is necessary to cause a fatal outcome.

Protection from this type of food-poisoning is relatively simple with canned goods. The toxin is quickly destroyed at the boiling-point of water, so that heating can be relied on as an absolute safeguard. If absolute safety is desired canned goods should be boiled before use, even if it is to be used subsequently for cold dishes.

No food should be used, however, which shows any evidence of spoilage, and canned goods, sausages, etc., which are suspicious should *never be tasted* to determine whether they are spoiled.

Adequate heating of canned goods and the use of 10 per cent. brine in pickling will prevent the subsequent development of the bacillus. An antitoxin can be prepared which will neutralize the toxin. This probably has therapeutic value if given soon after swallowing the poison. There are two types of bacillus, differing one from the other in the toxin produced. It is necessary therefore to have a bivalent antitoxin available if it is to be used in all cases. There is no data available as to the value of antitoxin in the treatment of the disease in man. Limber-neck in chickens and certain types of

forage-poisoning are forms of botulism. The cases of poisoning of any kind from canned goods are remarkably few.

EGGS.

Of all foods eggs are less liable to convey disease or contain harmful properties than any other single product or animal food. No infection of the hen or other bird, so far as known, is transmissible to man through its egg. Some persons, however, have an "idiosyncrasy" toward eggs resembling anaphylaxis, and eating of only a small quantity of egg-protein is liable to bring on an attack.

In the trade, eggs, besides being sold as fresh and refrigerated, are classified as "rots," "spots," "checks," "ringers," "checkers," "dirty shells," "heated," or "incubated," etc. They are assorted by inspection and candling. The eggs are held before a bright light or candle, when the movable yolk may be clearly seen, if the eggs are translucent, as well as the air space at the larger end. An expert candler soon detects the quality of the egg. Rotten eggs are known as "red rots" and "black rots," according to the putrefaction present. The opaque portions seen under the light are termed "spots," which may be due to molds that have got into the eggs through a crack in the shell, or to embryos or foreign bodies. "Checked" eggs are cracked eggs. "Ringers" contain small embryos of a ring or disk-like shape, while "checkers," as the name indicates contain larger embryos. "Heated" eggs are those which have been exposed to the heat of summer for several days and have become shrunken through loss of water by evaporation. Hence heated eggs are also known as incubated eggs. Spring and fall layings are more desirable than those collected during the summer months, for the above reasons, also because they contain fewer bacteria and thus keep better than eggs laid in the summer time.

Large quantities of eggs are now opened and mixed, then frozen or dried, and these products are much used by bakers and others.

POISONING FROM PLANT FOODS.

Many plants contain physiological poisons, such as aconite, strychnin, ricin, abrin, muscarin, and other substances which are normally present. Some plants contain certain parasites, such as rye and other grains, which produce ergotism. Poisons may also develop in putrefying vegetables as the result of bacterial action, which are perfectly wholesome when fresh. Certain vegetables, such as lettuce, celery, watercress, radishes, etc., which are eaten raw, may convey typhoid fever cholera, dysentery, both amebic and bacillary, the eggs and larvæ of animal parasites, and other infections. All vegetables therefore, which are to be eaten raw should be carefully washed beforehand, in order to cleanse them of impurities such as manure or other excrement, with which they may have become contaminated in the field or garden.

Reference has already been made to an unbalanced diet consisting largely of polished rice as the cause of beri-beri, and to a one-sided or faulty diet as the cause of pellagra. Urticaria and other anaphylactiform symptoms may be produced in susceptible persons by the eating of strawberries, blackberries, tomatoes and cereals.

Ergotism is a form of food poisoning produced by the prolonged use of meal made from grain containing the fungus claviceps purpurea, which develops in the flowers of rye and other grains. This affection is practically unknown in America, and is now becoming rare even in Europe, where it was not infrequently met with.

Mushroom-poisoning is due to eating a species of poisonous mushrooms through mistake for the edible varieties. Amanita is the most poisonous of the mushroom families. The symptoms come on suddenly after an incubation of six to fifteen hours with pain in the abdomen accompanied by great thirst, vomiting and profuse watery diarrhea, the victim finally sinking into a deep coma after four to eight days.

Potato-poisoning is due to poisonous principle *solanin* which is found in small quantities in those tubers of the potato, that have lain, during growth, partially exposed above ground, and in those which, during storage, have become well sprouted. Potatoes have long been known to contain minute quantities of this poison, but it is only under certain circumstances, as above noted, that the amount of the poison is sufficient to produce serious disturbance of the system.

PARASITIC ORGANISMS.

The Trichina spiralis, echinococcus and cysticercus, which frequently infest the meat of animals especially hogs, are capable of giving serious infection to man when meat infected by them and insufficiently cooked or raw is consumed.

The trichina is the most important of these. It frequently occurs in the flesh of hogs, rats, dogs, cats and other carnivorous animals. The common host of Trichinella spiralis is the rat, which gets infected about slaughter-houses and butcher shops. Hogs become infected by eating rats, through feces or directly from infected offal. Man secures the infection by eating trichinous pork.

The trichinæ are found in two forms: The mature worms inhabit the intestinal canal; the immature form is found in the striped muscle. This parasite was first described by Paget in 1833. Trichinæ are small, thread-like worms which, when found in the muscle or fat of pigs, are coiled in tiny cysts. To the naked eye they look like small white specks. Sections of muscle treated with weak caustic potash solution for a few minutes are rendered sufficiently transparent to reveal the coiled worm under a low-power lens. The muscle may be pressed out thin enough for examination by using an apparatus made of two pieces of plate glass. These plates are forced together by means of screw and bolt at each end.

The trichinæ gain access to their host in the following manner: Flesh containing trichinæ is taken into the stomach and digested. The enclosed worms are set free and mature in the intestinal canal. Here sexual reproduction occurs and each female worm produces hundreds

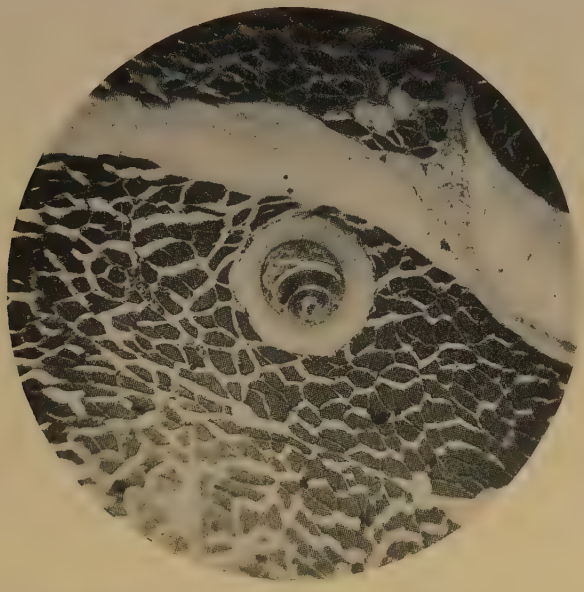

FIG. 56.—Trichinæ in human muscle, showing thickened capsule. × 75. (Harrington.)

FIG. 57.—Trichinæ in human muscle. × 75. (Harrington.)

of young. These young forms begin at once to migrate through the intestinal walls and other tissues until they become imbedded in the striped muscle.

Localized epidemics of trichinosis have been reported from time to time in this country and in Europe. Meat known to be infected should not be consumed, but when necessary it can be rendered harmless through cooking. A temperature of 70° C. destroys the life of the parasite within a few minutes. The frequent occurrence of trichinæ in pork emphasizes the fact that meat should never be eaten without thorough cooking. Salted and smoked pork are not free from danger. Uncooked ham and sausage are almost as dangerous as fresh pork.

The tape-worm is next in importance of the parasites transferred from meat to man. This in its larval forms exists in beef and pork respectively as Cysticercus bovis and Cysticercus cellulosæ. Such meats are known as measly. The animals are the intermediate host and man the final host. The Cysticercus bovis dies within three weeks after the slaughter of its host. Measly beef kept for three weeks in cold storage is therefore considered to be safe. It is killed in twenty-four hours by pickling solutions of common salt. It is not killed by ordinary smoking or salting. The Cysticercus cellulosæ is somewhat more hardy. Both forms are killed by a temperature of 60° C. for five minutes. The Bothriocephalus latus infects, in some localities, the sturgeon, pike, perch and salmon. It is rarely met with in this country. It is killed surely if the fish is properly cooked.

CHAPTER XIV.

THE SOIL.

By ARTHUR R. GUERARD, M.D.

Soil is a term applied to the superficial unconsolidated portion of the earth's crust, composed of broken and disintegrated (weathered) rock mixed with varying proportions of decaying organic matter (humus). The processes by which soils are formed from the parent rocks are mechanical and chemical, and sometimes biological. The fertility of a soil is in part determined by the character of the parent rock. Thus granite, richer in the elements of plant food, yields a more fertile soil than the silicious sandstones.

According to the method of their formation soils are classed as sedentary or transported. When a soil is found resting on its parent rock it is spoken of as sedentary soil. Such formation may show gradual transition from the fully formed soil at the surface to the solid rock beneath. With this class may be grouped the humus or peaty soils due to accumulations of organic matter in bogs, swamps and marshes. In many cases the residual products have been removed from the places of their formation by the action of water, ice (glaciers) and wind, and deposited elsewhere as clayey, sandy, or loamy soils, often representing the mingling of material from several sources. This type is termed transported soil, and, though naturally variable in character, includes some very productive soil. The most important soils of this class are the alluvial soils, such as occur in river and flood-plains and deltas, as in the case of the Nile and the Mississippi Rivers. In the northern half of the United States much of the soil is of the glacial drift type and represents the debris of rocks of various kinds brought down from the north during the glacial period.

Eolian soils are those formed by wind action. They include: (1) sand dunes, shifting, sandy soils heaped up by wind action upon ocean coasts and shores of inland seas and lakes; (2) ash soils, the accumulation of ashes ejected by volcanoes. The deposits are often of considerable extent and are frequently very fertile. Such soils are found in Nebraska, Colorado and Montana, and other volcanic regions.

Soils containing an excess of soluble salts are found scattered throughout regions of different or irregular rainfall and are known as alkali soils. Humus, peaty or moor soils are composed largely of organic matter. The purest types are represented by accumulations of peat formed in ponds and swamps; massive marshes and muck soils represent a less pure variety. When properly drained and aërated and freed from excess of soluble salts, they often prove very productive.

In practice soils are classified as gravelly, sandy, loamy, clayey, calcareous, humus, peaty, etc., distinctions based on the fineness of the soil particles and the relative proportions of sand, clay, lime and humus which they contain. Soils are also frequently classed as light and heavy, according to the ease or difficulty of tillage. The productiveness of a soil depends chiefly upon its chemical composition and its physical or mechanical properties. Chemical and physical or mechanical analysis separates soil constituents into two general classes: (1) plant food constituents and (2) physical constituents. The food constituents considered necessary to plant growth are nitrogen, sulphur, phosphorus, calcium, magnesium, potassium, iron and probably manganese, in various forms of chemical combination. The physical constituents, constituting the larger proportion (90 to 95 per cent.) of the entire soil mass, act as a mechanical support to plants and furnish a medium for root growth, but have little more than an indirect value as fertilizing agents. As a rule they consist very largely of silica.

Chemical Properties.—The average composition of soil of humid and arid regions in the United States is shown in the following table (Hilgard):

Constituents.	Humid region. Per cent.		Semi-arid region. Per cent.		Arid region. Per cent.	
Insoluble matter	84.17	88.21	75.04	83.50	69.16	75.87
Soluble silica	4.04		8.46		6.71	
Potash	0.21		0.33		0.67	
Soda	0.14		0.32		0.35	
Lime	0.13		0.70		1.43	
Magnesia	0.29		0.47		1.27	
Iron oxide	3.88		2.08		5.48	
Alumina	3.66		4.57		7.21	
Magnese oxide	0.13		..		0.11	
Phosphoric acid	0.12		0.21		0.16	
Sulphuric acid	0.05		0.02		0.06	
Humus	1.22		3.24		1.13	
Nitrogen in humus	*		6.67		12.50	
Nitrogen in soil	..		0.22		0.13	

* Less than 5 per cent.

Actual fertilizing constituents, viz., potash, phosphoric acid, nitrogen, lime, etc., are relatively small, arid soils showing larger proportions than humid soils. Other mineral constituents are usually present in sufficient qualities to supply the needs of plants. Humus is important as a soil constituent not only on account of its beneficial effect on the physical properties of soils, but as a source of nitrogen, as well as of available phosphoric acid, potash, lime, etc. The nitrogen of humus is converted into a form (nitrate) available for plants by the process of nitrification through the agency of microörganisms. This includes three stages, viz.: (1) the transformation of organic nitrogen compounds into ammonia; (2) the conversion of ammonia into nitrites; (3) the formation of nitrates from the nitrites. The first of these changes are brought about by a variety of organisms of the putrefactive class, the most prominent being *Bacillus mycoides* and *Proteus*

vulgaris, while the second and third are the work of specific organisms, *nitrosomes*, nitrous organisms and *nitrobacterin*, nitric organisms. The retrograde action known as denitrification, by which nitrates are reduced to the less highly oxidized forms and even to free nitrogen, is the work of microörganisms also of various kinds, some aërobic, others anaërobic. Humus may be said to be the final visible product of decomposition of organic matter in the soil, in the course of which a great variety of organic compounds, some beneficial, some harmful (toxic) to plant growth, are produced.

Physical Properties.—Physical properties of soils of special importance are color, weight, fineness of division or texture, structure of arrangement of particles, adhesiveness and relation to gases, heat, moisture and dissolved solids. Variations in these properties determine to a large extent the productiveness of soils. Good tilth and texture with accompaniment of good water conditions, aëration and temperature are fully as essential to plant growth as an adequate supply of plant food and may be in a measure controlled by man. Physical properties of soils are so largely dependent upon their natural character, and can be modified to such a limited extent by man, that it is of great importance to select soils with special reference to the natural suitability of their physical character to the crop to be grown. The physical properties of soils are determined also by the proportion they contain of stones, gravel, sand, clay, lime and organic matter. A sandy soil is dry, warm and easy to work, but as a rule naturally poor, with little absorptive power. A clayey soil is apt to be cold, wet and difficult to till, but to have high absorptive power. Clayey soils generally contain more plant food than sandy soils. Humus makes soils light in weight and dark in color and greatly increases absorptive power. Lime not only has value as a plant food, but improves the structure of soils and corrects acidity. It also promotes the decomposition of organic matter and nitrification and other biological activities. Mechanical analysis, which separates the particles of a soil into six or more grades of fineness, ranging from stones and gravel through sand and silt to clay, furnishes a valuable means of securing data for judging of the physical properties of soils.

The productiveness of the soil depends very largely upon its texture and structure, *i. e.*, the size of the particles and their arrangement. These determine the circulation of water and gases, solution and retention of plant food, and the growth of plant roots. When the grains are single or separated the soil is said to have a puddled structure, while a compounding of the soil grain gives a flocculated structure. The latter is desirable in all good soils, as it increases the pore space and facilitates the circulation of air and water through the mass. Flocculation may at times be caused by frost action, but more frequently is produced by the action of lime. Fertilizers vary in their action, some like nitrate of soda, producing puddling, others producing flocculation. The finer the soil particles the greater the injurious effects of puddling, clay soils suffering from this cause more than sandy

soils. Puddling increases the water-retaining power, thus retarding percolation, but may accelerate capillary rise of water. Flocculation decreases the retention of water, aids percolation and may retard evaporation. Water passes more easily from a coarse to a finer layer than from a fine layer to a coarse one—hence when the farmer firms the soil by rolling and then loosens the surface by harrowing, he destroys the capillary spaces and so checks the escape of water into the air. Water is held near the surface, and is readily accessible to the roots of plants. The action of mulch depends upon this principle. In humid regions the clay particles of the soil are usually washed down to a layer several inches below the surface, the surface layer being called the soil proper, and the lower one subsoil. In arid regions this difference does not exist, but the fine clay particles are evenly distributed throughout the soil layers. Soils vary widely in their absorptive power for water and for fertilizing matter. Of the three principal fertilizing constituents—nitrogen, phosphoric acid, and potash—soils apparently have the least retentive power for nitrogen (in the form of nitrate) and the greatest for phosphoric acid. The relation of soils to water probably more than any other one factor determines their productiveness. Water is not only necessary as a constituent of plant tissue, but it performs a most important function as a solvent and carrier of food in both soil and plant. The temperature of soils is modified by a variety of conditions, *e. g.*, a dark-colored soil is usually warmer than a light-colored one; soils so exposed as to receive a large amount of the direct rays of the sun are warmer than those not thus exposed; dry soils are warmer than wet.

Biological Properties.—Living organisms—roots of plants, insects, earth worms, etc., but especially bacteria—play an important role in soil formation and fertility. Bacteria aid in the disintegration of soil-forming rocks and increase the supply of available mineral plant food, fix free nitrogen both directly and in symbiosis with leguminous plants—viz., the group of bacteria known as *B. radicicola*—render organic nitrogen available to plants by nitrification or cause loss of soil nitrogen by denitrification, and in some cases produce substances in the soil which may be either harmful or beneficial according to circumstances. Recent investigation has indicated the practical possibility of curbing the harmful and promoting the beneficial microbiological activities in the soil by various methods of treatment, more especially by partial sterilization of the soil by means of heat or volatile antiseptics.

Soil Pollution.—The soil may be polluted in various ways and in widely differing amounts, but the nature and amount of pollution are of less importance relatively than the point of entrance. Some of these pollutions are unavoidable and others avoidable.

The unavoidable pollutions include the urine and droppings of animals, the carcasses of such as have died and have escaped the notice of other animals that act as scavengers and vegetable matters of all kinds in various stages of decay. These, lying at or near the surface, are of comparatively little importance, except under very unusual conditions,

when large numbers of horses, cattle and other animals are killed or die, as in time of war or flood or epidemics, since exposed to natural processes of purification, they are resolved into simple innocuous substances, which are absorbed by plant life or washed downward into the soil.

The avoidable pollutions are mainly those which man deposits beneath the surface, and these are first, and of minor importance, the bodies of the dead, and second, of vast importance, the excreta and other organic filth that constitute sewage. The temporary storage of filth in water-tight receptacles built under ground can, of course, do no harm to the surrounding soil. Water-tight cesspools gradually become filled and require to be emptied, but those with pervious bottoms permits the escape of the contents downward, the filth thus introduced is below the zone of bacterial activity of the beneficent kind, and becomes stored up in the subsoil or is washed away gradually by the ground water, which thereby is made unfit for human consumption. Organic matters deposited in the upper strata of the soil are resolved into their constituent elements with greater or lesser rapidity according to local conditions of distance from the surface, temperature, degree of moisture and permeability to air, the process advancing most rapidly in a well-ventilated, moderately dry soil near the surface, and most unfavorably in wet, compact soils, far from the surface.

In the decomposition of organic substances in the soil, no offensive odors are noticed, if a substantial layer of earth is interposed between them and the atmosphere. The soil has the faculty of absorbing gases and vapors just as it has the power to retain water in its interstices and on the surface of its constituent particles, a property which is illustrated in the common earth-closet. The soil acts in this respect like charcoal. Perhaps the most striking illustration of the affinity of soil for odors is the fact that illuminating gas from leaking street mains may be robbed of its odorous constituents by the soil to such an extent that, being drawn into houses with the soil-air, its presence often escapes detection until the production of poisonous effects attracts attention to the existence of an unusual condition of the air.

Soil Bacteria.—The bacteria of the soil are found almost wholly in the superficial layers; below a depth of 12 feet they are relatively few in number. They are far more numerous in rich garden soil than in ordinary sand and clays, due to the fact that they need organic matter for their growth and multiplication. In addition to the presence of organic matter, moisture and certain limits of temperature are also necessary for their development. Dryness and extremes of heat and cold are unfavorable for their growth. Saturation with water may or may not be unfavorable, according to the variety. In rich soil the number of bacteria ranges from hundred thousands to millions per cubic centimeter in the surface layers, below which they decrease in number very rapidly, until at ten to twelve feet below the surface, the soil is practically sterile, except for those that have been washed down or carried by burrowing animals, or deposited by man in organic filth.

The soil bacteria are mainly of the beneficent varieties, the saprophytes which perform useful offices, including the numerous kinds of the nitrifying organisms. While different species of pathogenic bacteria have been found in the soil, and though certain of them, such as the bacilli of tetanus and malignant edema are often present, this class of organisms finds, as a rule, the conditions in the soil unfavorable to development.

The relation of the soil to the various pathogenic bacteria will be discussed further under separate headings.

CHAPTER XV.

WATER SUPPLIES AND THEIR PURIFICATION.

By JAMES T. B. BOWLES, B.S.

Introduction.—In discussing the subjects of water supply and sewage disposal, the writer wishes to state that it has been his intention to introduce the latest and most approved theories that have developed on this subject.

To carry out this plan, he has used, not only the results obtained from his own investigations, during his wide experience in this and other countries, but has tried to bring out the accepted ideas of others who are working along this line.

The definitions of terms given are those which are generally accepted by all workers, as well as the standard methods for the examination of water and sewage.

In studying water supplies we find that the earliest method of artificially obtaining water was by merely digging wells, which at first were very crude in form, being only shallow holes in the ground. However, history tells us that the Chinese have been familiar with the sinking of deep wells through rock strata from an early period.

It is found that the greatest development of water works construction in the early times no doubt took place during the very prosperous period of the Roman Empire. Great aqueducts were constructed many miles in length. First of these was built about 312 B.C. and the last about 305 A.D. Besides the Roman aqueducts that were constructed at this time, water supplies were developed for other cities, such as Paris and Lyons in France, Metz in Germany and Seville in Spain.

Modern water works began to be developed in Paris and London at the beginning of the 17th century, and the development has been very rapid in both Europe and America since 1800.

SOURCES OF WATER SUPPLY.

The sources of water supply are, as a rule, divided into three classes, as follows:

1. Rain or snow water.
2. Surface water which would include ponds, lakes, streams and rivers.
3. Ground water, including springs and wells.

Rain Water.—When collected from a clean impervious surface in the open, it is the purest natural water. Rain water is collected in

barrels and cisterns to be used for drinking purposes, and this method is still carried on in some parts of the country. However, this source of water supply has never been looked very favorably upon by Sanitarians on account of the careless manner in which the water is stored. Furthermore, these cisterns and rain barrels are excellent places for breeding mosquitoes, and at one time were the main sources for breeding of the yellow fever mosquito which caused many epidemics over the country. Rain water, being very soft, attacks iron, lead, zinc and other metals, and for that reason storage tanks or delivery pipes should not be made of these materials.

The water should be filtered in order to take out the impurities found in the air of cities.

Surface Waters.—The waters included in this class are those from rivers, lakes, ponds and impounding reservoirs. Unfortunately streams are used as natural sewers of the regions which they drain, and for this reason water from this source should not be used without some method of purification.

Lakes and Ponds.—These are excellent sources for water supply if of sufficient size and contain no industrial or domestic waste. However, owing to the possibility of contamination from their water-sheds it would be the safest plan to treat these waters with liquid chlorine.

Impounding Reservoirs.—Impounding reservoirs are nothing more than artificial lakes or ponds. In many localities, especially in smaller ones, the town supply is obtained by placing a dam across a narrow valley through which a small creek flows. While this is often true of small towns, large supplies are also obtained in the same manner. For instance, it might be said that New York City obtains its supply by impounding a number of streams flowing from the Catskill Mountains.

Ground Water.—This class covers those obtained from springs, shallow and deep artesian wells.

Springs.—Springs are formed when ground water is caused to overflow upon the surface, as a result of geological formation. They are often found to be polluted, which might come from a number of different sources. A crack or a break in the geological formation would allow a direct seepage from a cesspool or a barn-yard to contaminate it. In another instance, unless the outlet of the stream is protected by a cement casing, surface washings may get into it and pollute the water.

Shallow Wells.—Shallow wells, as a rule, are very dangerous, as quite often they are nothing more than a hole in the ground which collects surface drainage. (See Fig. 44.)

A Deep or Bored Well.—A deep or bored well may be of different depths, depending upon the strata through which it is bored. It is always best to have these wells covered with a concrete casing in order to prevent frogs, mice and bugs from crawling around it. Such a means of prevention of surface contamination applies to all wells.

Artesian Wells.—Artesian wells generally refer to wells where the depth usually exceeds 75 to 100 feet. The waters of these wells are

FIG. 58.—Contaminated well. Pollution from privy and barn passes through rock fissures.

often high in mineral content as well as containing dissolved gases, and for this reason have certain medicinal properties. An artesian

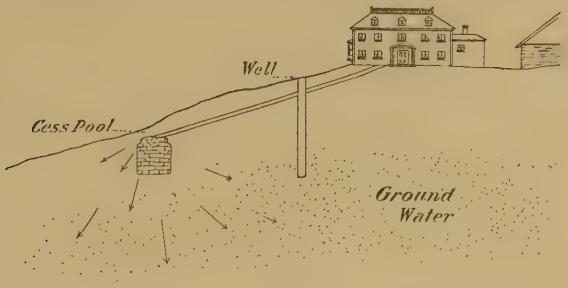

FIG. 59.—How a well located on high ground may be polluted by the contents of a cesspool lower down. (Harrington.)

water is very often impossible to be used as a general municipal supply on account of it causing trouble as an industrial water.

In classifying waters, certain accepted terms well-known to water

experts are used. For instance, we think of a water as good, bad or non-potable.

By the term good water is meant one that has a good sanitary quality when determined by physical inspection, bacteriological and chemical analysis, and a sanitary survey of the water-sheds.

By polluted or contaminated water is meant, one containing organic wastes of either animal or vegetable origin and this would be referred to as a suspicious water.

By an infected water is meant a water that actually contains the specific microbe or organism of human diseases.

The term potable means whether or not the water is drinkable.

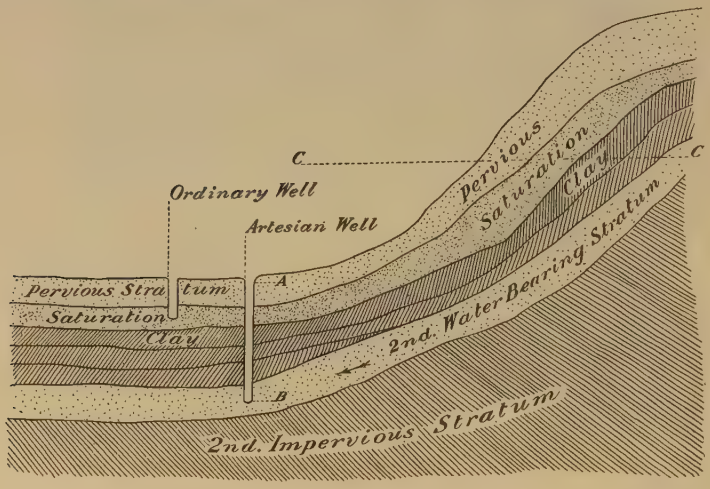

FIG. 60.—Geological formation favorable to the obtaining of water by means of artesian wells. (Harrington.)

THE CONSUMPTION OF WATER.

This depends upon a number of conditions. For sanitary reasons a generous use of water is always to be encouraged. For instance, the flushing of streets is the best known means for cleaning them. The installation of sanitary sewers is also most important, as in this way cesspools and privy vaults can be done away with. At the same time the conservation of pure water and the economic use of purified water should always be kept in mind.

The United States census report for 1915 gives the average per capita daily consumption of 201 American cities as 139 gallons with an average of 40 per cent. of their systems metered.

The average per capita consumption of 46 cities of New York State is 169 gallons per twenty-four hours, with an average of 52 per cent. of their systems metered. These statements are made to show the importance placed upon meters. Fifty American cities having at least 95 per cent. of their systems metered, reported a year ago that their

average daily per capita consumption was 79.4 gallons. Before meters were installed the average daily per capita of 25 of these cities was 153.2 gallons. Thus it can be seen that the only effective and economical method of reducing water waste and leakage to a minimum is through the general installation of meters.

DUAL WATER SUPPLIES.

In some instances a dual supply system has been thought to be economical and judicial to install. This consists of the use of an untreated river water or lake, which may be more or less contaminated but otherwise not objectionable for use in street washing, flushing of mains, sanitary connections and industrial works, when not used for drinking purposes. Then in combination with this system is another one which may be taken from the same source, but treated in such a manner as to make it a good, potable water. If not taken from a source as the first system described, it may be taken from another, such as deep wells, whose purity is assured.

The objection to a dual system is that there is always a chance for the water from a questionable source to be used for drinking purposes, or possibly a chance for the good water supply to be contaminated by the poor one. Such a system is not to be recommended except under extraordinary conditions.

THE RELATION OF POLLUTED WATER TO THE TRANSMISSION OF WATER-BORNE DISEASES.

Water supplies may be polluted by three classes of material: Vegetable and animal refuse, waste from human beings and waste from industrial industries.

If the water is contaminated from the latter source, unmixed with either of the other two sources, it cannot cause infectious diseases and can only be of danger to human beings using it in proportion to the amount of physical or chemical action which these wastes may have on the human body. Certain kinds of trade waste contains poisonous chemicals and even though diluted may cause trouble.

A water which contains vegetable or animal refuse but does not contain any human excrement will not be the means of transmitting any infectious disease to human beings, under ordinary circumstances. However, it is as yet more or less uncertain whether a water containing a large amount of organic matter of vegetable or animal origin, excluding that from human sources, is liable to cause pathological or disease conditions. For instance, such a water might be the means of stimulating gastro-enteritic and diarrhea in infants, young children or invalids.

When we consider the pollution of a water with waste from human beings, we find this kind of pollution the most important of all. Among the common water-borne diseases we have typhoid fever, dysentery, and cholera. However, it is possible to use for potable purposes a

water polluted with human excrement from perfectly healthy individuals who are not producing any disease bacteria, and yet not have any resulting disease from using such a water. The chief danger of using such a water is the possibility that a case or cases of water-borne diseases may at any time occur among a group of healthy persons, such as typhoid carriers, polluting the water. The liability of this polluted water to produce disease will depend upon two factors: Chiefly the amount of the pollution and the directness in which it reaches the consumer. If the infectious material is large in amount, but a relatively long period is taken for the water to reach the user, then the danger is less than if the amount is small and the avenue of travel and rate of passage are brief, because the bacteria of disease are generally short-lived.

In studying an epidemic of a water-borne disease, it is also advisable to make examination of the ice supply, as in some instances intestinal disorders have been attributed to the use of ice taken from a polluted water. As an example of this the following is quoted from Professor George C. Whipple's book on Typhoid Fever: "One of the most important cases was that of the St. Lawrence State Hospital at Ogdensburg, N. Y., in 1902, when 39 cases of typhoid fever occurred. The ice there used was unquestionably contaminated and in all probability infected with fecal matter from typhoid fever patients. Lumps of dirt were found frozen into the ice and it was alleged that typhoid bacilli were also found."

These important factors must be kept clearly in mind while determining official action regarding a water when checking over the analytical data.

The chemical and bacteriological examination of samples of water cannot give results which enable the interpreter to state that the pollution is either specific or non-specific; therefore the most critical dangers to a water supply cannot be determined solely from the results of laboratory examinations. They can only be determined by personal investigation or a thorough examination of the whole system with full knowledge at hand of the presence or absence of water-borne diseases on the water shed.

The laboratory examinations are often of much value in determining to some extent the following points:

The vegetable origin of contamination.

The animal, including human origin, of pollutions.

The relative amounts of such contaminations and pollutions.

The directness of such contamination and pollution when the latter is, or has been, present in considerable amount.

Thus it is to be borne in mind that these examinations can furnish data of a general character regarding a water, but this information alone will not generally be sufficient to warrant basing upon it a decision as to the potability of that water.

Furthermore, a single examination of a series of samples collected at one time furnishes information only of conditions at that time; and if the supply is liable to fluctuate in either amount or character,

then new conditions may be created, and the possibility of such fluctuations or changes cannot be determined by a single or even from a number of examinations.

This necessitates then, a constant supervision of a water supply which is subject to pollution whether it be direct or indirect.

SANITARY WATER ANALYSIS.

The standard methods as compiled and revised by the committee of the American Public Health Association, the American Chemical Society and Officials of Agricultural Chemists are recommended for use in the examination of water and sewage. These methods are published in book form and can be obtained from the American Public Health Association, 113 Market Street, Lynn, Mass.

In outlining the determinations that are made in a water analysis with the interpretation of their results, the writer does not claim to introduce any original ideas here, but desires to give the plan that has been accepted by the Committee on Standard Methods, and to use the accepted terms and phrases commonly expressed by well-known authorities on water supply. Unless some such standard or a recognition of a definition of the terms and phrases so used, be accepted, it is difficult to instruct the reader how to properly interpret a water analysis.

When a complete sanitary analysis of a water is made, it covers:

1. A physical examination to determine color, turbidity, odor and taste.
2. A microscopic examination to determine the numbers and character of particles in suspension, especially algæ.
3. A chemical analysis to determine the nature and amount of chemical impurities.
4. A bacteriological examination to estimate number and kind of bacteria.
5. A sanitary survey of water-shed, including methods of collecting, handling, storing and distributing the water.

The object of a sanitary chemical analysis is not to determine the amount of certain compounds of carbon, hydrogen and nitrogen in the water because these compounds are in themselves not dangerous, but to determine the absence or presence of, and, if present, the amount of such compounds as will aid us in tracing the past history or the present condition of the particular water that is being studied.

For this purpose we determine the amount of organic matter, living or dead, that is suspended or dissolved in the water, the amount of certain of the products of decomposition of organic matter, and the amount of certain minerals dissolved in the water.

Each class of waters has its own characteristics. The significance of any given factor must be judged separately for each particular case.

Physical Examination and Interpretation of Results.—Odors in water are very objectionable. As a rule the most objectionable ones

develop in surface waters and are caused by the growth of algæ, diatoms, protozoa and other microscopic beings. In the case of deep wells, hydrogen sulphide and other inorganic compounds may give odors to the water. Odors and tastes develop in impounding reservoirs from stagnation and putrefaction of organic matter.

Certain organisms can be distinguished by their odor, as the "fishy" odor of uroglena, "aromatic" odor of asterionella and "pig pen" odor of anabæna, which is one of the blue green algæ. Odors caused by undecomposed organisms are due to compounds of the nature of essential oils. Algæ are responsible for bad tastes and odors in water.

Removal of tastes and odors may be accomplished through various means of aëration and by treatment with copper sulphate.

Color in water is usually from a vegetable origin, such as dead leaves, bark or roots. If the water contains iron, it will be perfectly clear on coming from the ground, but will soon turn a rusty yellow color, caused by oxidation of soluble ferrous salts to insoluble ferric salts.

Removal of color may be brought about through storage, because of bleaching action and precipitation. Different means of aëration are also used. Coagulants, such as aluminum sulphate, iron and lime, are added to water containing color. The chemicals combine with the coloring matter and form a precipitate which drops out of suspension, leaving a clear supernatant liquid.

Turbidity is synonymous with muddiness, usually due to clay or silt. This may also be removed by the use of a coagulant, or, if the turbidity is sufficiently coarse, it may be filtered out without previous chemical treatment.

Reaction.—The alkaline reaction of natural waters ordinarily depends upon carbonate and bicarbonate of calcium and magnesium. The incrustants are caused by the sulphates, chlorides, nitrates and silicates. Acid constituents are represented by aluminum and iron sulphate.

Water Softening.—The carbonates represent the temporary hardness and are removed by boiling, and also by the addition of lime. The sulphates and chlorides cause a permanent hardness, and are removed by the addition of sodium carbonate. However, there are certain commercial compounds that are used at the present time, which give much satisfaction in water softening.

Chemical Analysis.—According to standard methods, results are now expressed in parts per million (p. p. m.). One milligram in 1000 c.c. equals 1 part per million. One part per million equals 0.058 grains per U. S. gallon.

The total solids furnish an index of the total quantity of foreign impurities and further furnish a rough index of the relative quantity of inorganic and organic substances which make up the inorganic matter.

Organic Matter.—Organic matter in the soil and that passing through it with the ground water is of two main kinds, carbonaceous and nitrogenous. These may become oxidized CO_2 CH_4, and H_2. These end-products are rarely reached in nature as the result of decomposition

of organic matter in the soil. Carbonaceous matter comprises the cellulose bodies. These may be oxidized to carbon dioxide. The nitrogenous matter comprises albumins, the waste of animal life, and proteids. These may be oxidized to nitrates. The organic matter in itself is not dangerous to health, but is undesirable because it putrefies and thus gives the water disagreeable tastes and odors; besides this, it offers food for bacterial growth.

Nitrogen.—Most of the difficulties in securing a satisfactory water supply are connected with the cycle of nitrogen in its relation to organic life.

Nitrogen is found as an essential constituent of all living matter. When thus combined it is called organic nitrogen, and is found in undecomposed vegetable substances. As soon as dead these substances become food for microörganisms.

Nitrogen is determined as: (1) total nitrogen; (2) nitrogen as free ammonia; (3) nitrogen as albuminoid ammonia; (4) nitrogen as nitrites and (5) nitrogen as nitrates.

Nitrogen as Albuminoid Ammonia is an approximate measure of nitrogenous organic matter from two sources, vegetable and animal proteids, and amino bodies from vegetables are much more stable than from sewage and evolve nitrogen less rapidly. The amount is therefore an index of pollution. Organic matter of animal origin yields a larger amount than of vegetable origin. As a rule the albuminoid ammonia in a surface water should not exceed 0.3 p.p.m. and ground water as a rule not more than 0.15 p.p.m.

Nitrogen as free ammonia is the result not only of decomposition of nitrogenous organic matter, but is also formed during the process of denitrification, by which nitrates are again reduced to nitrites and nitrities to ammonia.

In a surface or ground water free ammonia represents one of the latter stages of putrefaction of organic matter; thus, the bacteria decomposition of sewage yields large amounts of ammonia. The ammonia itself ordinarily found in drinking water is harmless; its significance lies in the fact that it indicates the presence of putrefying organisms.

Its presence in clean and properly stored rain water has much less significance than in a surface or ground water.

Deep well waters of exceptional purity and practically sterile, may contain a relatively high percentage of free ammonia. This is supposed to come from a chemical reduction under high pressure and perhaps temperature of the geological nitrogenous matter in coal and alluvial deposits. In general, free ammonia is less of a danger signal than the albuminoid ammonia. More than 0.15 p.p.m. must be regarded as suspicious.

Nitrogen as nitrites is an indication that either oxidation of organic nitrogen or decomposition of nitrates is taking place. It represents the transitional stage of oxidation of organic matter between ammonia and nitrates and therefore indicates incomplete oxidation of the protein

and the active growth of bacteria. As a rule, pure water contains no nitrites, or only traces. However, nitrites may be absent from an impure water owing to the fact that the oxidation has not reached this stage or, perhaps, has entirely passed it. The absence of nitrites, therefore, does not mean that the water is necessarily safe, while their presence in any but the smallest measurable amounts shows pollution. Usually high free ammonia values and high nitrite values go hand in hand, as both processes are usually going on simultaneously. Nitrites are a danger signal in the same sense that the colon bacillus is a danger signal, indicating pollution but not necessarily infection, for they do not tell the source or nature of the organic matter.

Nitrites are not only formed by the nitrifying bacteria in the soil from the ammonia, but are also formed from the denitrification of nitrates by a variety of microörganisms. The typhoid bacillus, the colon bacillus and many other bacteria have the power of producing nitrites in culture media.

Nitrates.—The final step in the mineralization or nitrification process is the conversion of nitrites into nitric acid, which combines with a base to form nitrates. In the form of nitrates, the nitrogen is completely mineralized and nature's cycle of conversion has been completed. Their presence, therefore, signifies past or distant pollution, while the absence of nitrates does not necessarily indicate their presence and on the other hand, does not necessarily indicate immediate danger. If the water contains an appreciable quantity of nitrates and no nitrites, it shows that the sources of pollution have been distant, and that the organic matter has been completely oxidized. In waters considered pure the nitrates are rarely less than 0.3 part, or may run as high as 1.6 parts, per million according to some authorities. A water may contain a large amount of nitrates and also a considerable amount of free ammonia and nitrites. Such a water has been incompletely purified and usually contains a considerable number of bacteria, and if some of these are of human origin the water is, of course, unsafe.

On the other hand, there may be a large amount of nitrates and free ammonia, and nitrites be practically absent. Such a water would be one that had at some time been badly polluted with organic matter, but this material has been mineralized by the purification processes. Waters in this condition generally show low bacterial counts and the absence of fecal organisms, but it requires a high degree of purification to completely remove the fecal bacteria, and consequently the danger of infection.

Chlorine.—The organic matter found in water is not stable, but is in a state of transition until it is completely mineralized; but the compounds of chlorine are very stable, and when they once gain access to water they remain to bear witness against it and to serve as a tell-tale of past bad associations. It is because of this fact that so much significance is given to the chlorine content of water.

The legitimate sources of chlorine in natural waters are from the sea and from the natural deposits of salt that are the remains of pre-

historic seas. Storms break up the waves into spray, which is carried inland by the wind currents and with it small particles of salt. This spray is washed down by the rain, so that all surface water contains some salt. The quantity is quite proportional to the distance from the sea coast, so that several hundred miles inland it is only present in small quantities, while near the sea coast the quantity is considerable, so that where it is not a natural constituent of the earth, as in the salt regions of New York State, the normal amount of chlorine for a surface water from any given locality can be quite accurately determined, and any excess above this amount is an indication of pollution by animal or human wastes.

Salt being used in the domestic animal diet and to a much larger extent in the human kitchen, is therefore found in the animal and human wastes; and when such wastes reach a water, the presence of this excess chlorine will indicate animal or human pollution which may have been completely mineralized, yet the chlorine remains to show what has been the condition in the past.

It has been estimated that chlorine content in the annual drainage of any water-shed is increased one-tenth part per million per twenty inhabitants per square mile.

The mixture of even a small proportion of sea water renders the water hard and salty and undesirable for domestic use. The writer has had an extensive experience with the mixture of sea water and fresh water at Miraflores, Canal Zone. It was found there, that a water containing 60–70 parts per million of chlorine caused trouble with the boilers and this particular water supply was later abandoned.

Oxygen consumed is synonymous with oxygen required and oxygen absorbed. This is a measure of carbonaceous organic matter which is partly oxidized by $KMnO_4$ solution. Water which oxidizes rapidly usually contains unstable carbonaceous matter. Oxygen consumed is closely related to color.

Dissolved oxygen represents the degree of aëration or oxygenation of water. The amount of oxygen in solution is fairly constant in waters of uniform composition freely exposed to the air. Water containing sewage and other oxidizable matters uses up the dissolved oxygen.

The absence of dissolved oxygen permits the growth of anaërobic organisms that cause putrefaction and impart putrid tastes and odors to waters.

The amount of oxygen found in the water of a running stream taken at different points may furnish valuable information as to the rapidity with which the process of self-purification is taking place from a chemical standpoint. When the dissolved oxygen is used up, the fish die off. Gasch, Marsson and Hofer have found undoubted evidences of a close relation between an insufficient amount of dissolved oxygen and fish diseases of both a parasitic and bacterial nature. If dissolved oxygen is absent from ground water, sulphates may be reduced to sulphides and hydrogen sulphide set free.

Carbonic acid may exist in water in three forms: free carbonic acid, bicarbonate and carbonate. The carbonic acid of the carbonate plus half that of bicarbonate is known as the "bound carbonic acid."

Carbon dioxide from decomposition of organic matter is first of importance in ground waters. It greatly increases the solvent action of water which may cause corrosion of the water pipes.

Iron in water influences its quality from the standpoint of desirability rather than from the standpoint of health, and after hardness there is no question of greater practical importance in considering the quality of a water. All natural waters contain a certain amount of iron and ground waters are apt to contain it in objectionable amounts, which, with the presence of organic matter, promotes the growth of crenothrix. This organism is very troublesome in water pipes. The solution of the iron is brought about by the organic matter. The iron exists in the soil as ferric compounds. These are reduced by the organic matter to ferrous salts, which are soluble in water containing carbonic acid. When ground waters containing iron are first drawn they look clear, but the ferrous salts in solution are soon oxidized on contact with the air to insoluble ferric salts, which are precipitated as red oxides.

Iron Removal.—One part per million of oxygen, oxidizes 7 parts of iron. Acids, organic matter and manganese interfere with the precipitation of ferric hydrate. Most of the carbon dioxide must be eliminated. Aëration for removal of iron is applied in several ways by foundations, pre-filters, which consist of a very coarse filtering medium; sunlight also assists in the precipitation of iron.

Lead.—Chemical tests for lead should be made. No water should be used for drinking purposes containing even a trace of lead. The source of lead in the water is almost always from lead service pipes or some other object used in collection, storing or delivering the water.

Microscopic Examination.—The main object of the microscopic examination of water is to determine the presence or absence of those microörganisms which produce objectionable tastes and odors. The determination is also of value as an index of pollution. The organisms comprise the Diatomaceæ, Chlorophyceæ, Cyanophyceæ, Fungi, Protozoa, Rotifera, Crustaceæ and other minute organisms not including bacteria.

The microscopic examination may be considered in five parts:

1. Indicating sewage contamination when such organisms as Beggiatoa and miscellaneous objects as yeast cells, starch grains, fibers of wood and paper, threads of silk, etc., are noted.

2. As indicating progress of self-purification of streams by noting changes in the character of microscopic organisms.

3. Explaining chemical analysis. Large amounts of albuminoid ammonia might show a large amount of living sewage pollution. Possibly the sudden decrease in nitrates may be caused by some microscopic organisms using the nitrogenous food.

4. As explaining the cause of turbidity, odors, etc. This has been explained under the heading of odors earlier in the chapter.

5. As a means of identifying the source of a water (in special cases). The presence of certain microscopic organisms in water gives a clue to its origin. In this way the presence of a surface water may be detected.

6. As a method of studying the food of fishes, oysters, and other aquatic organisms. Where there are no plankton, there is no fish. Plankton refers to minute floating animals and plants that are drifted about by waves and currents.

Limnology is that branch of science that treats of lakes and ponds, their geology, geography, physics, chemistry, biology, and the relation of these to each other.

Temperature which is taken by means of a thermometer or thermophone, together with the study of dissolved gases, are very important items to be considered.

High excess of chlorine seems to accompany heavy growths of organisms.

Seasonal Distribution.—During the winter the lake will contain very few organisms.

Horizontal Distribution.—Under this heading we have: *Littoral* organisms which include all those forms that are attached to the shore or to plants on the shore. Limnetic organisms are those that make their home in the open water.

Vertical Distribution.—The protozoa as a class seek the upper strata of water.

Removal of growths was taken up under the heading of odors.

Bacteriological Examination of Water.—The number of bacteria is not as important as the kind; however, the number corresponds to the amount of organic pollution. Different temperatures are used for growing the bacteria as they do not all grow at the same temperatures. Pathogenic bacteria do not grow as well as saprophytic varieties at 20° C., and the latter often do not grow at all at 37° C. A water containing great numbers of bacteria when counted upon gelatin or nutrient agar at 20° C. and but few colonies upon agar at 37° C. has little sanitary significance, while the reverse would be looked upon as suspicious. The distinction between polluted waters and waters of good quality is more sharply marked by counts at 37° C. than is the case with counts at 20° C. Also, the results from the plates grown at a higher temperature are available in a much shorter time.

The determination of the number of bacteria in water is of great value when studying surface waters, such as lakes and rivers. As a rule, the number of bacteria is proportional to the pollution of the river, not necessarily fecal matter but pollution from any dead organic matter. A river contains more bacteria in winter than in summer, or we might say that the number of bacteria in a stream is an index of its turbidity. The numerical determination is also useful in determining leaks in a water supply. It is also useful in determining the efficiency of a filter.

In the routine bacteriological analysis of a water we do not attempt to isolate the specific typhoid organisms but only those organisms which have a fecal origin, and some of the reasons for this follow.

What is not a natural habitat for typhoid bacilli, and the majority of them probably die off in a short time. As there is a period of incubation between the infection and the recognition of the disease, it is possible in water-borne cases for the typhoid bacilli to have disappeared from the water before the disease has been recognized.

If the source of the water was a flowing stream and the infection was occasional and not constant; the search for the organism would, of course, be useless. Under such conditions, even if our laboratory technic were perfect, we would not be able to prove our case.

The typhoid organism has been occasionally isolated from water supplies; but the laboratory technic is not simple, and the practical difficulties are such that we know of no laboratory which attempts it as a routine procedure.

B. Coli Communis.—In water laboratories the isolation of the bacilli of the B. coli communis type is the routine procedure. These organisms are normal inhabitants of the intestinal tracts of man and of warm-blooded animals. The inference is that as they have an intestinal origin their presence indicates fecal matter, and some of these feces, if of human origin, may at times contain typhoid organisms.

If the laboratory examinations show organisms of the B. coli communis type to be absent, we can definitely say that the water is safe; but if the examinations show that they are not entirely absent, we could not definitely say that the water was dangerous. As we are not able to differentiate between the organisms of human and of animal origin, the mere presence of a few bacteria of the B. coli communis type does not necessarily indicate pollution from human beings, as they might be entirely of animal origin, coming from pasture lands or fertilized fields; but if the organisms are persistently present in small volumes of the water, say in 1 c.c. or less, the water should be considered unsatisfactory, for even though most of the organisms may be of animal origin they are generally accompanied by those from human wastes.

Therefore it is the number of B. coli found in a ground water, as in a surface water, rather than the *mere presence*, which is of sanitary importance.

That the mere presence of B. coli proves the presence of infinitely rarer disease germs is inconceivable (Flinn, Weston and Bogert).

The permissible numbers of B. coli in a ground water is difficult to determine. As a rule B. coli should not be present in 1 c.c. samples of water, nor in more than 20 per cent. of 10 c.c. samples. It will rarely be found in the best ground water even in 100 c.c. samples or in more than 10 per cent. of 10 c.c. samples from most undeniably safe sources. Waters from peaty deposits show B. coli.

Presumptive Tests for the Colon Bacillus.—These tests are sometimes used to determine the presence of B. coli and while unreliable, sometimes afford useful information. This is merely the water grown in lactose bile or lactose broth fermentation tubes. If gas is obtained confirmatory tests should be made by plating out on different kinds of media.

If large numbers of B. coli are present gas often forms in a few hours. Small numbers of somewhat attenuated B. coli may require three days to form gas. Attenuated B. coli does not represent recent contamination and all B. coli not attenuated grows readily in lactose bile. No other organism except B. Welchii gives such a test in lactose bile. B. Welchii is of rather rare occurrence in water, is of fecal origin, is almost invariably accompanied by B. coli and while the sanitary significance is the same, it may, if desired, be distinguished from B. coli by a microscopic examination of the bile solution when long strings of much larger bacilli than B. coli are seen, as well as spores.

The specific organisms that are found in water and may cause their corresponding diseases are B. typhosus, cholera vibrio, dysentery bacillus, certain forms of ameba causing amebic dysentery, tubercle bacillus.

Sanitary Survey.—The preceding discussion of sanitary water analysis makes it quite evident that, except in those cases where fecal pollution is entirely absent, a sanitary analysis can seldom definitely establish the fact that a given sample of water is from a supply which is either entirely safe or absolutely dangerous. It can point out probable danger, and as such is an aid to be used in connection with other sources of information.

When we speak of a sanitary survey we mean the obtaining of the actual knowledge of the physical conditions surrounding the source of the sample, the possible sources of pollution, the geology of the watershed, the slope of the ground, etc. In order to make as accurate determinations as possible, it is absolutely necessary to have this knowledge. Samples that are sent into the laboratory should always be accompanied by all possible information as to the history and source of the water.

Single or occasional determinations of either the chemical or bacterial constituents of a water are of little value. In fact, it is often misleading, especially in surface water.

A river water may require repeated examination extending over long periods of time. A routine bacteriological analysis shows pollution but does not prove infection. However, the bacteriological analysis tells us more of the present state of the water while the chemical refers more to the past state. A sanitary survey of the catchment area is frequently of much greater practical importance than all the information furnished by the laboratory. By a sanitary survey we are able to discover the sources of contamination, the kinds of pollution, and the degree.

TREATMENT OF WATER SUPPLIES.

Most of the early efforts toward water purification had for their purpose the removal of suspended materials, which rendered the water offensive to sight or taste, and it was not until the demonstration of the Altoona, Germany, filters during the cholera epidemic in the city of Hamburg in 1892, that the remarkable hygienic efficiency of such efforts

was suspected or even appreciated. Since then the introduction of water purification plants have progressed by leaps and bounds throughout the world. In 1916 it was estimated that in the United States 30,000,000 people were being supplied with water either filtered or sterilized, or both. This progress has been greatly stimulated by the popular regard of the germ theory of disease, the published record of water-borne epidemics and the great advance during recent years of the bacteriology of water supplies.

The wonderful results that have been obtained by the use of liquid chlorine in the disinfection of water supplies, has brought the development of water purification to a very high point.

Among the various methods used in the purification of water supplies are the following:

1. Clarification.
   - (*a*) Aluminum sulphate.
   - (*b*) Iron and lime.
2. Filtration.
   - (*a*) Slow sand filters.
   - (*b*) Mechanical rapid gravity filters.
   - (*c*) Drifting sand filters.
   - (*d*) Pressure filters.
3. Sterilization.
   - (*a*) Chlorine.
   - (*b*) Copper sulphate.
   - (*c*) Ultraviolet ray.
   - (*d*) Ozone.

Classification.—In purifying waters carrying large amounts of clay particles, or waters with a large amount of coloring matter, it is customary to use a coagulant, such as aluminum sulphate alone, or a combination of iron and lime. These chemicals coagulate the clay particles and also form a chemical compound with the coloring matter which causes it to form a precipitate, or what is known commercially as a "floc" or drops out of solution and falls to the bottom of the sedimentation basin, leaving a clear supernatant liquid. All waters that are very turbid and contain much coloring matter, must be treated in this manner before filtration.

Filtration.—Slow Sand Filters.—Slow sand filters have been popular until a few years ago. The most elaborate plants of this type are at Albany, Washington, Philadelphia, Providence, etc., where the waters treated are relatively much less in turbidity.

This type of sand filter is of English origin and consists of a bed of selected sand $2\frac{1}{2}$ feet to 5 feet in depth, resting on 12 to 15 inches gravel of about $\frac{1}{2}$ to 1 inch in diameter, underlaid with open jointed tile or drains. The water to be treated is applied until the bed is well covered and thereafter at substantially uniform rates of from two to five million gallons per acre daily for a period of usually from three to four weeks, when the filter is taken out of service and cleaned by scraping off the film of intercepted impurities which has accumu-

lated on the top of the filter from the water. This film of protozoa, bacteria and microscopic plants increases the efficiency of the filter and it is largely due to this film that the biological changes in the organic impurities take place. The higher the temperature of the water the greater the activity of the organisms. At temperatures below 40° F. the changes produced are negligible. The water which is collected from the under-drain is relatively pure and unless previously polluted with discharges from human beings will require no further treatment. Where such a previous pollution is known to have occurred, it is usual to chlorinate the water before or after filtration. Filters of this type are usually constructed in units of about one acre each and are covered with masonry roofs where the winter temperature is sufficient to produce thick ice.

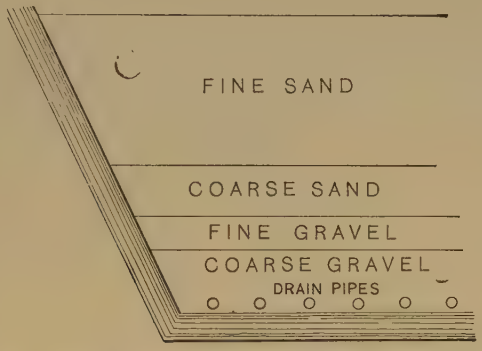

FIG. 61.—Partial vertical section of one form of filter bed. (Harrington.)

Mechanical Filters.—The rapid sand filter, known as the mechanical filter, is of American origin and has been used since about 1880.

It differs from the slow sand filter in its rate of filtration, from 125 to 150 million gallons per day. They were primarily intended to remove evidences of turbidity, and are used in conjunction with coagulation and sedimentation.

The filter consists of a tank made of wood, steel or concrete in which is placed the filtering material which rests on a system of strainers and under-drains for collecting the filtered water.

The filtering material consists of about 12 inches of graded gravel on top of which is placed 30 inches of graded sand.

The water which has previously been treated with a coagulant and has passed through a sedimentation basin, is allowed to flow on to the filter bed through a system of troughs. by gravity. When the filters become clogged, they are put out of commission and washed. First the water is drained down to the surface of the sand, then in some instances, compressed air is turned on from beneath, to agitate the sand bed and break up any hard mats of dirt. Then the air is turned off, and water turned on from beneath the bed of filter to wash out the dirty material into the sewer. After sufficient washing, the filter is

again put into commission, allowing the filtered water to go to waste for a few minutes, before turning it into the clear water well. Examples of this type are: Cincinnati, Ohio, New Milford, New Jersey, St. Louis, Missouri, Panama, Grand Rapids, Michigan (see Fig. 62) and many others.

Pressure Filters.—Another type of a mechanical filter is the pressure filter. It consists of a closed tank with a filter bed similar to the above type, and is operated by admitting the settled water under pressure. As this filter is closed, it is impossible to see what is going on and for that reason cannot be given the proper attention.

FIG. 62.—Operating floor of rapid mechanical filtration plant, Grand Rapids, Mich. (Courtesy American City Magazine.)

This type of a filter is useful for small supplies, as on private estates or for swimming pools, but is too expensive and not efficient enough for municipal water supplies.

Sterilization.—The third method of purification of water known as sterilization is brought about by the use of a disinfectant in the water. This may be by some form of chlorine: copper sulphate, which is nowadays seldom used except as an algicide; the ultraviolet ray and ozone, efficient but at the present time too expensive and impracticable for municipal supplies.

Chlorine.—Chlorine is the most important of all disinfectants that are used in the purification of water supplies.

It is formed by the electrolytic decomposition of salt solutions. The moist gas evolved from the electrolytic cells being dried and compressed into liquid and shipped in steel cylinders of approximately 100 pounds capacity.

The history of the development of chlorine, in its application as a

disinfectant to water supplies, reveals probably one of the most important as well as interesting uses for this gas.

The germicidal power of calcium hypochlorite, commonly called "Bleach" has been known since the early fifties. Among the first pieces of work that was done in regard to the sterilization of water, by the process of chlorination was that which was undertaken in 1905 by Dr. A. C. Houston, of the Metropolitan Water Board of England, using sodium hypochlorite with gratifying results.

In this country the first attempt to use this process on a large scale was at Bubbly Creek Filtration Plant, Union Stock Yards, Chicago, Illinois. At this place, calcium hypochlorite was used, and the results accomplished brought about the acceptance of this process as a very important method of water purification.

Following the Bubbly Creek experiments, a chlorination plant using hypochlorite was installed at several places, among which the most important was that at Jersey City.

The use of liquid chlorine began to supplement hypochlorite in 1910, owing to the development by Messrs. Wallace & Tiernan, of an apparatus necessary for this application to water supplies. The perfection of the apparatus resulted in a rapid use of liquid chlorine in the sanitary field to sterilize water and sewage. Much work has been done by Professor Earle B. Phelps in regard to the effective use of chlorine in treating sewage.

Liquid chlorine is a far more efficient and economical sterilizing agent than chloride of lime. Some of the advantages being as follows:

Liquid chlorine is an absolutely pure chemical and is placed on the market in small cylinders which require very little space for storing while chloride of lime is very bulky and requires much greater space. Chloride of lime deteriorates rapidly, whereas liquid chlorine retains its full efficiency indefinitely. This is of special advantage where small installations are made.

Under working conditions due to unavoidable waste of bleach, one pound of liquid chlorine is equal in sterilizing value to from 6 to 8 pounds of chloride of lime. The sterilization is more uniform and better bacteriological results are obtained. Also water treated with liquid chlorine is less liable to have taste or odor due to the more accurate control. Liquid chlorine control apparatus requires little more than daily inspection, and insures continuous service, while the apparatus for the application of chloride of lime requires constant attention to prevent clogging of orifices,. The saving accomplished is frequently in excess of 50 per cent.

Description of Apparatus.—The chlorinating apparatus regulates the flow of chlorine gas and applies it where needed. Upon releasing the pressure in the cylinder, the chlorine changes from a liquid to a gas. The gas passing from the cylinder is controlled and measured by the apparatus and introduced into the water or sewage in proper proportion to effect sterilization.

There are two general types of chlorinators: one by which the dry

chlorine gas is introduced to the water or sewage, and the other by which the chlorine gas is first dissolved into a small amount of water and the resulting chlorine solution piped to the point of application. These two general types are adapted to be operated under manual or automatic control.

The amount of chlorine required is dependent entirely upon the

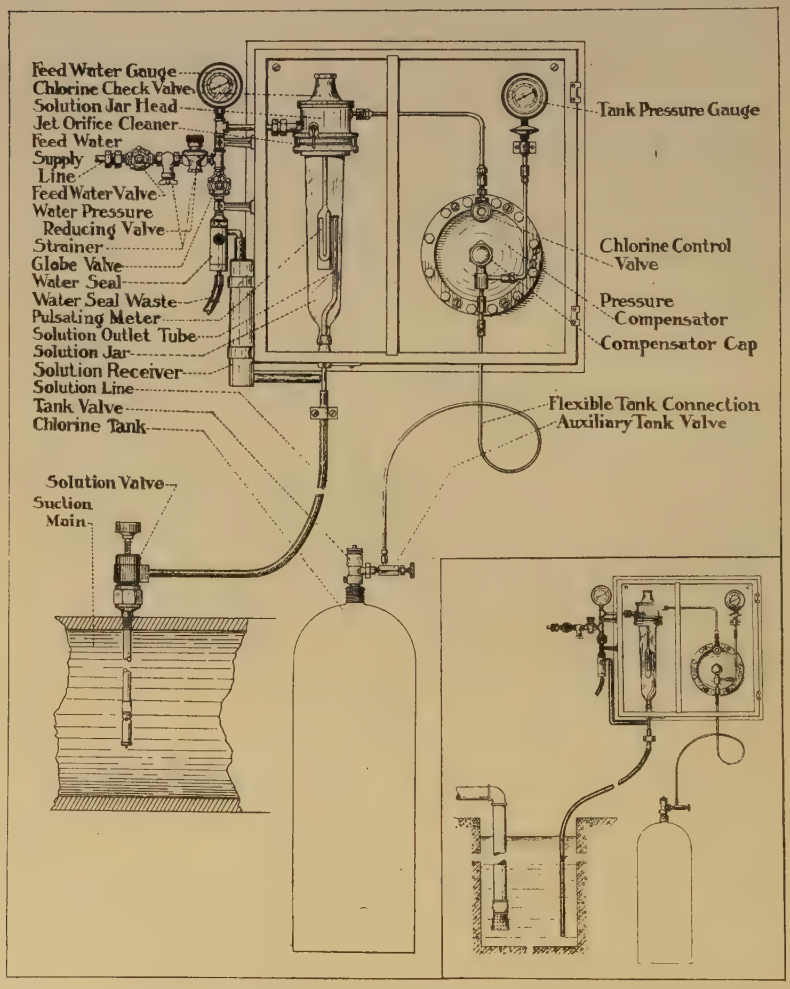

FIG. 63.—Chlorinator, showing how to be operated. (Courtesy, Wallace & Tiernan Co., Inc.)

composition and quality of the water to be treated. It is found, from general practice, that a filtered water requires from 0.12 to 0.40 p.p.m., spring or well water from 0.20 to 0.50 p.p.m., and raw surface water from 0.30 to 1.00 p.p.m.

Point of Application.—The point of application is of the utmost importance in the chlorination of water. The source of supply, method

of treatment, distribution, and local conditions influence the point of application, and therefore the type of apparatus recommended.

The following points should be borne in mind:

A raw, untreated water requires more chlorine for its proper sterilization than a filtered or clarified water.

If a coagulant is used, a saving in chemicals is sometimes effected by introducing the chlorine before the coagulating chemical.

With a filtered water, where possible, chlorine should be applied after filtration rather than before.

Chlorine should be introduced as near to the inlet of the distributing system as possible to avoid pollution subsequent to chlorination.

A chlorine control apparatus should be installed in a substantial structure provided with heating facilities to insure a minimum temperature of 50° F.

The Action of Bleach When Applied to Water.—The disinfecting action of bleach can be most conveniently considered by regarding it as a heterogeneous mixture of reactions.

On dissolving bleach in water, the first action is the decomposition of calcium oxychloride into an equal number of molecules of calcium hypochlorite and calcium chloride.

$$(2)\quad CaOCl_2 = Ca(OCl)_2 + CaCl_2$$

Solutions of pure hypochlorite are alkaline in reaction because of excess of hydroxyl ions. In solutions of bleach the hydrolytic action is retarded by the OH^1, due to free base, and accelerated by the excess of H^1. The addition of any substance that reduced the OH^1 concentration enables hydrolysis to proceed to completion; thus the addition of weak acid as boric acid yield a solution of hypochlorous acid.

The Action of Chlorine When Applied to Water.—When a solution of chlorine in water is used as a germicide the chemical reactions that occur differ materially from those of hypochlorite solutions.

The general reactions are of three types:

1. Oxidation of organic matter.
2. Direct chlorination of the organic matter.
3. A bactericidal action.

If water contains appreciable amounts of organic matter almost all chlorine is consumed in first reaction, and even in filter effluents oxidation accounts for quite a bit of chlorine consumed. It is this reaction that determines the dosage required for effective sterilization.

In reference to the second reaction, it is more than probable that chlorinated derivatives are largely responsible for the obnoxious tastes and odors produced in some waters. It has been suggested that these were due to the formation of chloramines.

Very little is known about the nature of the third reaction. It is possible that chlorine and chlorine compounds exert a toxic action on microörganisms.

Copper Sulphate.—Copper sulphate has been used to sterilize water supplies and very good results have been obtained, especially in the Philippines in killing cholera vibrio.

Its greatest use is as an algicide and as such it gives excellent results. It was first used by Moore & Kellerman, of the U. S. Department of Agriculture, in 1903.

The amount of copper sulphate used depends upon the kind of algæ present, and a table is given below with the proper amounts. The amounts used are so small that there is no possibility of any injury to the human consumer, which is further prevented by the fact that the copper reacts with any calcium that may be present in the water and is precipitated;

Asterionella,	0.8	pounds per million gallons of water.	
Spirogyra,	1.7	"	"
Anabamena,	0.8	"	"
Oscillaria,	1.7	"	"
Urogelina,	0.4	"	"
Crenothix,	2.5	"	"
Beggiatoa,	41.51	"	"

These quantities apply to water at about 60° F. The quantity to be increased by about $1\frac{1}{4}$ per cent. for each degree below this and decreased at the same rate for each degree above it.

Ultraviolet Ray and Ozone.—Ultraviolet ray and ozone are both used to a small extent in water sterilization and give a certain degree of satisfaction.

These methods are very expensive and can only be used with a water that is very clear and colorless, otherwise sterilization is very poor.

WATER PURIFICATION IN THE FIELD.

During the recent war, the purification of water in the field for the American Expeditionary Forces was carried on by some means of chlorination, which led to the development of the following mobile outfits; "Steri-lab," "chloro-pumps" and "mobile-lab."

The "steri-lab" consisted of a three-ton chassis, carrying a gasoline driven pump of double acting piston type, capacity 20 gallons per minute, operated against pressure of 100 pounds per square inch, 50 feet 2-inch hose, a foot valve and strainer. The suction hose is put down in a well or stream and water pumped direct to a Roberts pressure filter, connected with an alum pot. Chlorine gas was applied at pump suction, the dose being heavier than in ordinary municipal work, and the surplus chlorine is removed by dechlorinating with thiosulphate solution. The filtered and sterilized water passes to a discharge valve where it can be fed to tank cart or stationary storage. It would sterilize 1200 gallons per hour. In the front part of the truck is a well equipped laboratory for all necessary chemical and bacteriological tests.

The "chloro-pump" consisted of a $1\frac{1}{2}$-ton chassis carrying a pump with a capacity of 40 gallons per minute and a chlorinating apparatus, but no laboratory.

The "mobile laboratory" consisted of a 1½-ton chassis carrying a well equipped laboratory for necessary chemical and bacteriological tests.

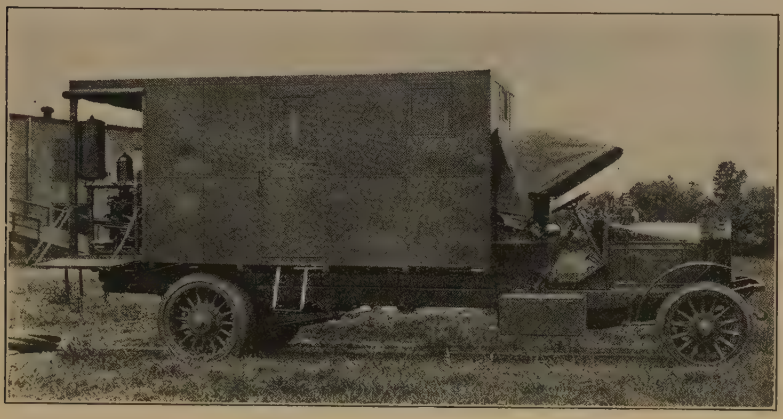

FIG. 64.—Ready for the road.

All of these units were found to be most useful in sterilizing water for troops and would be very applicable for use with boards of health in emergency work or in a construction camp.

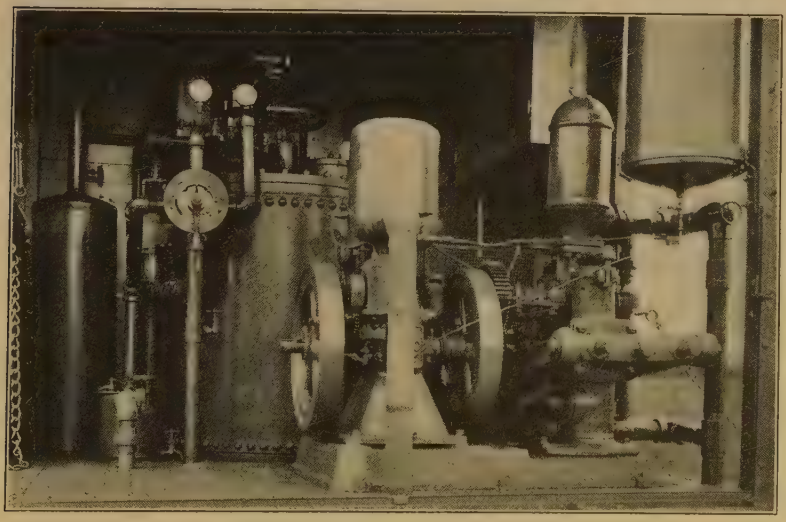

FIG. 65.—The mechanical equipment.

The Lyster bag was also used and in some instances the water was sterilized in the bag. This was done by breaking a small ampoule of

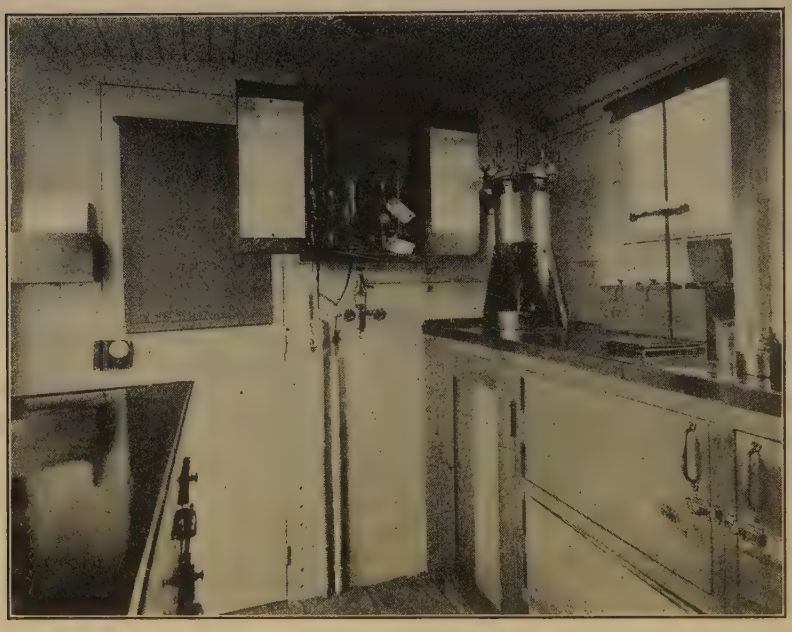

FIG. 66.—Chlorinator in laboratory.

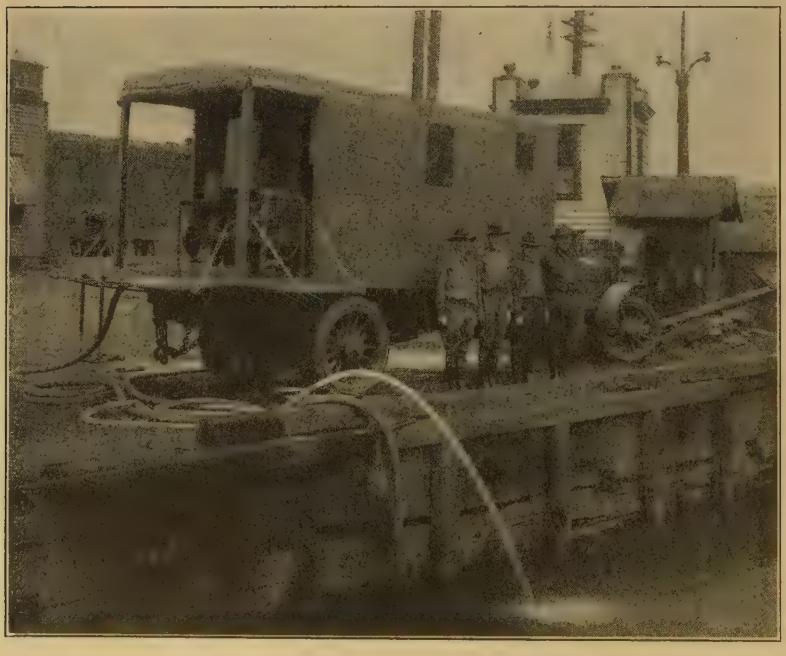

FIG. 67.—Equipment in operation.

calcium hypochlorite and dissolving it in the water. There was a great deal of dissatisfaction from the use of this method as often the hypochlorite was found to contain practically no chlorine and it also gave the water a taste to which the soldiers objected.

FIG. 68.—Another view of the laboratory.

FIGS. 64 to 68.—Mobile water purifying and testing outfit used with the American Expeditionary Forces in France. (Courtesy of Wallace & Tiernan Co., Inc.)

Water carried in the carts was often sterilized by use of "Javelle water" or bleach. Enough was added to the water to show a small amount of free chlorine when tested.

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CHAPTER XVI.

SEWAGE AND WASTE DISPOSAL.

By JAMES T. B. BOWLES, B.S.

SEWAGE.

Introduction.—In discussing this subject the writer has endeavored to carry out the same ideas as those under the subject of Water Supplies and Their Purification; that is, he has used not only the results obtained from his own investigations, but he has tried to bring out the approved theories of others, that have been developed on this subject and in so doing has used the definitions of terms which are generally accepted by all workers.

The term sewage is taken to mean the solid and liquid water wastes from human habitation and manufactories, including slaughter houses, etc., diluted with the water used. It is quite obvious that sewage varies greatly for different periods of day and night and according to the character of the community.

The decomposition of organic material without the production of offensive odors is accomplished by bacterial life naturally present and when provided with sufficient quantities of oxygen. The rapidity of such decomposition depends upon whether the oxygen can be immediately brought into intimate contact with all parts of the organic matter or whether disintegration or molecular change must first occur. This is known as aërobic decomposition. The decomposition of organic materials by bacteria naturally present and which do not require oxygen is the more rapid process of disintegration, and this is usually accompanied by the production of foul and offensive odors. This is known as anaërobic decomposition.

The disposal of human excreta in rural districts where it is impossible to use a modern sewer system is a very vital problem. The old-fashioned country privy for the disposal of excreta has been not only very disgusting and a great nuisance, but also a vast disseminator of typhoid fever, dysentery and hookworm. Filth seeps and soaks through the ground and contaminates wells and springs.

The United States Public Health Service and the various State Boards of Health have designed different types of sanitary privies, which have been of great service to the rural communities; the general idea being to have a water tight, concrete vault and that it be well ventilated; fly proof, and easily accessible for cleaning. The vault is divided into two portions, so that when one is filled the other side can be used while it is being cleaned. In some instances dry earth or sand is thrown into the vault occasionally to absorb the liquid portion.

When necessary to be cleaned the excreta is removed and buried in shallow furrows.

For more detailed information in regard to the sanitary privy, see references Florida State Board of Health Publications, 1919, and Public Health Bulletin, 1918–19, U. S. Public Health Service, Washington, D. C.

The easiest method of disposing of sewage from a town or city is to discharge it into a body of water. This is known as the dilution method. Here the natural forces that transfer putrescible organic material into inorganic and inert material are brought into play. This change must be brought about without causing nuisance.

The factors influencing the successful disposal of sewage by dilution are:

(*a*) *Suspended Matter.*—Suspended matter, which, subsiding, forms sludge deposits that deplete available oxygen in the overlying water, thus producing objectionable conditions. This condition is dependent upon the velocity of the current into which the sewage is discharged. Velocity less than 3 feet per second may permit this.

(*b*) *Sufficient Diluting Water.*—This should be approximately 6 cubic feet per second per 1000 persons contributing sewage or a dilution approximately 1 to 50. (This figure is dependent upon velocity and oxygen content of diluting water, also character of sewage discharged.—G. W. Fuller.)

(*c*) *Diluting Water to Maintain Oxygen Balance.*—While there is still oxygen in water containing organic matter the condition of putrefaction is not possible. The more free oxygen per unit of volume of water the greater its oxidizing power. Water saturated with oxygen contains at ordinary temperature and pressure about 10 parts per 1,000,000. If the sewage contains about 500 p.p.m. of organic matter it is evident that 50 volumes of water are required for complete oxidation.

When dilution is not possible, artificial treatment must be resorted to. In the artificial purification of sewage different objects are sought, namely:

(*a*) To improve esthetic conditions by preventing discharge of offensive floating matter into a stream. Method of treatment involving use of mechanical or physical processes, such as screens, grit chambers or plain sedimentation basins.

(*b*) To prevent a nuisance (oxidation process, such as filtration).

(*c*) To prevent introduction of objectionable bacteria into a stream (sterilization, by hypochlorite or liquid chlorine).

These objects are brought about by the following methods or by combination of these methods:

1. *Screening.*
   - (*a*) Coarse.
   - (*b*) Fine.
2. *Sedimentation.*
   - (*a*) Rapid in grit chambers.
   - (*b*) Slow in settling basin.
     With chemical precipitation.

(*c*) Accompanied by liquefaction of solid matter as in septic tank.
With sludge digestion in separate tank (Imhoff tank) or modified Imhoff tank.
Plain spraying into the air.
With the aid of sludge from previously aërated sewage (activated sludge).

3. Oxidation by means of filtration.
   (*a*) Contact bed treatment.
   (*b*) Sand filters.
   (*c*) Trickling filters.
4. Sewage irrigation on farms.
5. Disinfection treatment with some form of chlorine.
6. Miles acid process.

The method or methods to be decided upon depend upon the object to be attained, the requirements of the particular situation, the size of community and the amount of money to spend.

In making an analysis of sewage the following determinations are usually made (see *Standard Methods of Water and Sewage Analysis*):

(*a*) The total solids.

(*b*) The portion of the total solids that is dissolved.

(*c*) The portion of the total solids that is suspended.

(*d*) The settling solids (the portion of solids capable of settling out in two hours).

(*e*) The mineral matter (the portion of total solids remaining after ignition).

(*f*) The organic matters (the portion of total solids lost in ignition).

(*g*) Organic nitrogen (a measure of the amount of nitrogenous organic matter).

(*h*) Albuminoid ammonia, which is a measure of the less stable portion of the nitrogenous matter.

(*i*) Free ammonia, the first step in the "nitrogen cycle"—a measure of how far and at what rate transition is being made from organic to inorganic conditions.

(*j*) Nitrites and nitrates (the conversion of ammonia products into nitrites and nitrates known as "nitrification" marks the ultimate change in the biological purification of sewage).

(*k*) Oxygen consumed (a measure of the quantity of organic matter in which nitrogen is absent).

(*l*) Putrescibility tests—to determine if there is a sufficient supply of oxygen present to bring about complete oxidation of organic matter present.

It is the *organic* matter in sewage that causes *trouble*. The object of *sewage* treatment is to remove it or to *convert* it into mineral matter. When sewage is treated to deprive it of its objectionable features, one or both of two fundamentally different processes are employed:

(*a*) Actual removal, such as thorough screening.

(*b*) Conversion of putrescible matter into stable substances. Sewage treatment is usually accomplished in successive steps, the degree of purification increasing with each step and with care of operation.

Screens.—Various sizes are used, from the coarse rack, that merely removes heavy material as rocks, cans, boards, for a protection to machinery, to the very fine that supplements sedimentation basins, by removing the greater part of the putrescible organic matter. The coarse screens are usually stationary, while the fine screens are operated mechanically, either on the rotary or the conveyer system. Screens are now being used where some partial method of purification is essential:

(*a*) To remove floating suspended matter that would be objectionable to the eye, or that might cause local nuisance.

(*b*) Where after chlorination sewage can be safely turned into a stream without danger of nuisance or of infecting drinking water.

Results Accomplished by Screens.—Coarse screens $\frac{1}{2}$ inch mesh remove 5 to 10 p.p.m. (parts per million) suspended matter.

Fine screens 0.2 inch mesh, remove 25 to 160 p.p.m. suspended matter.

Sedimentation.—Grit Chambers.—Grit chambers are intended to remove heavy material, such as sand, gravel, bits of coal and cinder known as "grit." It is desirable to eliminate this material to protect the pumps from clogging and because it assists in disposal of sludge from settling basins. Its removal is accomplished by sedimentation in small basins by retarding the velocity of flow through the basin. Grit settles according to its size and specific gravity. In general a velocity of one foot per second is allowed for subsidence.

Results Accomplished by Grit Chambers.—Removal of 10 to 40 parts per 1,000,000 of suspended matter.

Plain Sedimentation.—In this process sewage is allowed to stand or flow very slowly through tanks where the solids capable of settling under existing conditions gradually subside to the bottom and is known as sludge. There is no aim to encourage bacterial action or to remove the colloidal matter which will not settle unaided in from two to eight hours, as this is of no great amount.

Detention Period.—The heaviest matter settles first; this is followed by the lighter particles. The period may be very short, perhaps thirty minutes, but it rarely exceeds two and a half hours which is equal to a flow of 120 feet.

Results Accomplished.—The suspended solids removed depend upon the detention period. Usually a detention period of two and a half hours will permit a removal of about 65 per cent. of the suspended matter. With the longest practical detention periods not much greater removal can be accomplished, and Mr. G. W. Fuller states that most of the work is accomplished in the first 40 feet of flow, and is effected only slightly by temperature.

Chemical Precipitation.—The old idea of chemical precipitation was to remove a greater quantity of the suspended matter by mixing with the sewage one or more soluble chemicals, which, reacting with themselves or some inorganic substances in the sewage, form a precipitate which drags down with it suspended matter. The most common chemicals used were ordinary lime, aluminum sulphate, or sulphate of iron.

Results Accomplished.—The results depend upon the quantity of chemical precipitant used. In actual practice 50 to 75 per cent. of the total suspended matter and 80 to 90 per cent. of bacteria are removed.

Removal of suspended matter by sedimentation and chemical precipitation involves another problem, viz., disposal of the sludge or settled material which is removed about once a week. This is the greatest difficulty in the application of sewage disposal by chemical precipitation. The attendant expense has prevented its general adoption and has even caused its abandonment where originally installed. The desire to diminish the attendant problems of sludge disposal has led to the development of various types of sedimentation tanks that aim to further sludge digestion. For ordinary sewage this method has passed away.

Miles's acid process consists of precipitating the sewage sludge by adding sulphuric acid, in order to obtain grease from the sewage; the remainder of the sludge to be used for fertilizing purposes. This has not been tried on a very large scale but on small experiments and with certain types of sewage has given fairly good results. See report city of New Haven, Conn., 1918–19.

Septic Tank.—This process, aside from the physical sedimentation of solids depends upon anaërobic bacterial action. This anaërobic bacterial action or septicization causes a breaking down of the complex substances into simpler ones. Insoluble substances are also changed into soluble ones as a result of bacterial activity through enzymes. (See reports Massachusetts Institute Technology Sewage Experiment Station.) The primary object of this tank is sedimentation, the period varying from eight to twenty-four hours. Sedimentation takes place in contact with decomposing sludge. The decomposition of the sludge is accompanied by the production of gas and a reduction in the quantity of sludge.

Results Obtained from Septic Tanks.—Thirty to 70 per cent. of the sludge by volume is converted into gas. Reduction in weight of solid matter is from 40 to 50 per cent. All the settling solids and a portion of the colloidal solids are removed. Violent ebullition diminishes efficiency of this process as regards sedimentation and often carries out large quantities of finely divided solids. This is especially bad if the effluent is to be treated at once with chlorine. The effluent frequently has an offensive odor, a great absorption power for dissolved oxygen and may contain substances inimical to oxidizing bacteria. Since it depends upon anaërobic bacterial action it should not be used preliminary to a method involving oxidation processes brought about by aërobic bacteria.

Imhoff Tank.—The object here is to digest the sludge in chambers apart from the sewage in the sedimentation tank in order that the gases evolved will not mix with the clear liquid at the top. There are two chambers: a sedimentation chamber (upper chamber) and a sludge digestion chamber (lower chamber). The function of the upper part is to remove the settling solids. The sewage is passed through as

quickly as possible, avoiding the exhaustion of the supply of oxygen. The action in the sludge chamber is similar to that of the septic tank. The solids accumulate in this chamber continuously and are digested by the bacteria. The gases pass out through openings or ventilators at the top of lower tank.

Results Accomplished.—Practical detention period is about four hours. This permits a subsidence of 50 to 60 per cent. of the total suspended matter.

Contact Filters or Biological Filters.—The failure of various tank treatments to remove fine suspended matter and the necessity of oxidizing organic matter of tank effluents before their discharge into natural waters led to the development of processes for transforming this organic matter into stable substances. The first of these was the contact or bacteria bed. This is a tank filled with broken stone, cinders, coke or other inert material. The material is about $\frac{1}{2}$ inch to 2 inches in size and the depth of the bed is about 6 feet. The voids in the bed, originally 40 to 50 per cent., gradually become filled with solid material and the contact material has to be removed and cleared after about five years' service. Bed with 20 per cent. voids will have far less capacity than one with 40 per cent. They are built in series of two or three. The effluent passes from one bed to another, being improved in quality by each successive treatment. Contact beds are filled with sewage, allowed to stand full, emptied and allowed to rest.

The following schedule illustrates such a cycle:

Rate of filling, 2 hours. However this is not so important.
Contact period, 2 hours.
Rate of emptying, $1\frac{1}{2}$ to 2 hours.
Time of resting, 2 hours.

Normal results are not obtained when beds are new. Rapid draining tends to retard the formation of film.

The work accomplished by the contact bed is dependent upon two main forces, physical and biological. It removes by surface attraction and absorption colloidal and dissolved substances which are later oxidized by bacterial action into stable inorganic compounds. The oxidizing power of the bed is dependent upon the supply of atmospheric oxygen absorbed during the rest periods. At intervals the biochemical activities need regeneration by obtaining oxygen from atmosphere or from nitrates.

Results Accomplished.—General evidence shows that contact beds will give a non-putrescible effluent when they treat from 125,000 to 150,000 gallons per acre per day for each foot of depth of effective filling material. Standard practice is a rate of 600,000 gallons per day for beds with an effective depth of 4 or 5 feet. Removes an average of 60 per cent. of applied bacteria, and 60 to 80 per cent. organic matter.

Sprinkling Filters (known as trickling filters, percolating filters, etc.). —These were developed from the contact filter, with the object of attaining higher rates of filtration and to eliminate serious complica-

tions from clogging but are less expensive in some cases than contact filters. Filtering material is of broken stone, size 1 inch or 2 inches diameter; usual depth of bed, 5 to 7 feet. Bottom of bed is watertight and has an underdrain system which collects effluent. Sewage is applied to beds in fine spray by means of fixed sprinkler nozzles whereby sewage is saturated with atmospheric oxygen.

Method of Operation.—Sewage after treatment, such as settling in tank usually applied intermittently, a dosing period and a resting period. Dosing is regulated by a tank of fixed capacity which gives the nozzles an operating period of from two to five minutes. The resting period depends upon the rate of filtration, and is usually such that when the filter is operated at maximum rate it is about three times the dosing period. Resting is a disadvantage during the cold season.

Results Accomplished.—A sprinkling filter can satisfactorily treat sewage at a rate of 2,000,000 gallons per acre per day. A disadvantage of this type of filter is that it discharges suspended solid matter, which must be settled by allowing effluent from the filter to be retained for a short period in sedimentation tanks. Even with this, better results for cheaper cost can be attained than with any method thus far developed. Experience shows that 80 to 90 per cent. of the bacteria can be removed.

Intermittent Sand Filtration.—This method is generally used without preliminary treatment other than coarse screens or grit chambers. It consists of applying small volumes of sewage to areas of porous sand, allowing the sewage to drain from the pores of the bed, then fill with air, and in repeating the dose some hours or a day later. It affects a higher degree of purification than can be obtained by any other method in use. The effluent from it is stable and is free from turbidity and color. It removes about 99 per cent. of the bacteria present in the raw-sewage.

The filtering material is sand, either fine grained or coarse. The rate of application for raw sewage will average 60,000 gallons per acre per day; the usual depth of the filtering material is from 4 to 6 feet. When there has been preliminary treatment the rate can be increased.

Intermittency.—Intermittent dosage is essential as continuous filtration would allow no time for oxidation to proceed. The cycle should be regulated so that there is always sufficient oxygen present in the pores of the material and that the oxidizing processes are not discontinued and the anaërobic process allowed to begin. (See Report of Massachusetts State Board of Health, 1908.)

Activated Sludge.—This process consists of aëration of sewage in tanks in contact with sludge from previously aërated sewage. The object of aëration is:

1. To supply sufficient oxygen to support the aërobic action of bacteria.

2. To produce sufficient agitation of the tank contents to assure intimate contact of the activated sludge particles with all of the

sewage. The time required for aëration increases with the strength of the sewage and the degree of purification required. In practice it seems to be better to apply air at a constant rate and vary the period of aëration rather than to attempt to regulate the air discharge to meet the needs of the sewage at the moment. Four or five hours' aëration with 20 per cent. sludge has given sufficient purification at Milwaukee, Wis. Approximately 2 cubic feet of air per gallon of sewage is required. Twenty to 40 per cent. of activated sludge is considered adequate. There is intimate relationship between the period of aëration, the quantity of air required and the proportion of activated sludge. This is accomplished by continuous aëration of activated sludge until nitrification is complete. It is in this condition that sludge is most active. The degree of purification effected by this method is dependent upon the maintenance of the activity of the nitrifying organisms. The activated sludge treatment appears to accomplish work comparable with an efficient intermittent sand filter. This process is still in an experimental stage, but has many points of promise, particularly a possible commercial value to the sludge.

Sterilization of Sewage.—This treatment is for the purpose of destroying objectionable bacteria, particularly germs of intestinal disease.

Two methods of chlorination:

1. Hypochlorite of lime.
2. Liquid chlorine.

The most satisfactory results have been obtained by the application of liquid chlorine to sewage, which has superseded the use of hypochlorites, as was brought out in the discussion in the chapter on Water Supply.

Required doses:

Crude sewage, 4 to 12 parts per 1,000,000 of chlorine.
Septic effluent, 10 to 15 parts per 1,000,000 of chlorine.
Sprinkling filter, 3 to 4 parts per 1,000,000 of chlorine.

The required dose depends upon the amount of unstable organic matter present in the liquid to be treated.

Efficiency.—The dose stated should remove 95 to 99 per cent. of the bacteria present. The time of contact has an influence in the efficiency of the process. In practice this is usually about thirty minutes.

Sewage Irrigation.—In this process sewage is applied intermittently to land at a rate so low that it does not interfere with the raising and harvesting of crops. Rate varies from 3000 to 12,000 gallons per acre per day. Objections to its use relate to odors, prejudice to use of sewage in growing of vegetables, also to transmitting of disease germs by flies and other insects.

Sludge Disposal.—Accompanying all sedimentation processes there is always the attendant necessity for disposal of sludge. This is a bothersome problem on account of two main reasons:

1. The unstable nature of the material.
2. The expense due to the large percentage of water in sludge (85 to 98 per cent.).

Sludge has a limited commercial utilization on account of its fertilizing properties, also on account of the grease that may be extracted from it.

Methods of disposal:

1. Digestion, then air drying.
2. Sludge pressing, usually confined to chemical precipitation plants.
3. Application to land.
4. Dispersion into water (large cities with harbors).

Conclusion.—Sewage purification is effected in successive steps, the degree being dependent upon the conditions to be satisfied. Examples of a method to be followed to secure an effluent that is thoroughly stable and will not cause putrefaction would involve following:

1. (*a*) Grit chamber for removal of sand.

(*b*) Imhoff tank and sludge drying beds (tank to remove suspended matter and permit digestion of sludge so that it can be dried on beds without causing nuisance).

(*c*) Sprinkling filters—for oxidation of organic matter in solution, with accompanying basins for sedimenting the filter effluent.

2. (*a*) Removal of suspended matter with fine screens.

(*b*) Intermittent sand filtration.

3. Final stage is disinfection or sterilization.

The essentials of any process are securing the best results with least cost. Since the carrying out of the above processes is largely chemical and biological in its nature it is essential that the operation of all disposal plants be under the direction of someone thoroughly understanding the processes involved. It is often found that sewage treatment plants fail on account of poor operation of the plant.

WASTE DISPOSAL.

Municipal Waste Disposal.—Very often when the word garbage is mentioned it brings to mind all kinds of refuse, instead of merely the waste from food. Garbage represents the kitchen waste including the refuse from the table as well as spoiled and unused food which is thrown away.

In technical terms, rubbish includes paper, loose material accumulated during construction work, empty cans, broken glassware, etc.

Street sweepings consist of horse droppings, dust, paper and miscellaneous refuse material found on street pavements.

Collection and Disposal of Refuse.—The amount of garbage per capita for a city averages 194 pounds, while rubbish amounts to 1250 to 1500 pounds per capita per month. In cities where natural gas is used, rubbish would be much greater. During the past year or two the high prices paid for iron, paper, leather, etc., all tend to decrease the amount of rubbish. The largest item in refuse consists of ashes. It costs more for the collection of ashes than for other materials but it gives the least trouble for disposal.

In the collection of refuse there are a number of schemes that have been employed, such as patented wagons with covered tops, motor

trucks, etc., and all have their special advantages. For instance in large cities where houses are close together, horse drawn wagons are advantageous while for small cities motor trucks are much more economical. In some places a method has been installed which consists of collecting *covered* cans and at the same time leaving a clean one in its place. When this is carefully done it gives satisfaction.

The method of collecting depends upon the kind of disposal that is to be installed. For instance if garbage is wrapped in paper, collected twice a week in summer and once a week in winter, the additional cost does not exceed 25 per cent. for collection and disposal. Wrapped garbage is all right for incinerators but not advantageous for dumping. For this reason it is necessary to study the collecting system in a city as well as the system for disposal of garbage.

The separation of garbage from other waste is more necessary than other classes of refuse because of the putrescibility of garbage; heat and cold affects it, uncovered garbage brings flies, and eggs are sometimes deposited in it.

Disposal of Waste.—The disposal of waste is being taken care of by dumping, burning, reduction, incineration and separation of garbage for feeding purposes.

The process of dumping as commonly practised is to be condemned. There are times when such a method may be used but the material should be placed in furrows rather than on one main dump, and as much of the combustible rubbish deposited among the wet garbage as possible in order to serve as fuel for burning. Strict attention should be given to see that all material is burned and afterward the ground be sprinkled with oil to prevent any fly-breeding from unburned material. There is much trouble caused from the smoke and fumes, which are offensive, from the burning material; also papers blow about and make the place very uninviting.

The burying of garbage and refuse is very seldom practised, as it takes quite a large space of ground and the results are not very satisfactory, at the same time being a very great waste of material.

The process of reduction is practised in Los Angeles, Cal., New Bedford, Mass., New York City and elsewhere. Much trouble was found from gases and fumes at first but a new process has been devised which takes care of this and diminishes the nuisance. Garbage is placed in a closed tank, sealed with jacketed walls and bottom containing steam and a device in the center to keep the garbage stirred all the time. Garbage, which contains 75 per cent. of water, is evaporated by the heat of the steam. Later solvents are added in order to dissolve the grease. Later the grease is obtained by the evaporation of the solvents, which are used over again in the extraction work. For large communities a garbage reduction process is quite advantageous. There is an increasing demand for waste products from garbage for the manufacture of fertilizer. The grease that is recovered splits up into various by-products; glycerin being the most valuable.

The process of incineration consists of burning everything—garbage,

refuse and all waste material except metals and glassware. This is carried out through high temperature destructives, the heat from which is used for power to obtain city light.

Feeding of Swine.—Each 1000 of population produces food waste sufficient to fit 25 hogs for market. At the present price, a ton of garbage produces seven to eight dollars worth of pork.

From many considerations, garbage might well be termed a war time discovery, brought about through high prices, the shortage of food and the patriotic response to the need of war time conservation.

The housewife evidently decided to solve the garbage problem by eliminating garbage. She unquestionably cut down materially not only the volume of her kitchen and table refuse but even further reduced its meat and fat contents.

Figures Obtained from Statistical Division of United States Food Administration.—The following are figures obtained from a survey of 96 cities with an estimated population of 26,000,000, reporting regularly each month for two years.

There was 10 per cent. less garbage collected in 1917 and 1918 than in the previous year, which shows a genuine conservation of food by the urban population.

In regard to the grease recovery from garbage, only a comparatively few States had reduction plants. However, twelve cities showed a reduction of 30 per cent. of gross grease recovered from garbage in 1917 and 1918 as compared with 1916. The average per cent. of grease in garbage dropped from 2.15 to 1.85. The 1918 grease content of garbage in richness averaged 18 per cent. less than 1917. Compared with 1916 it showed a reduction of 25 per cent. The total volume of garbage grease recovered showed a reduction of 28 per cent. from the 1917 recoveries and the 1917 recoveries exceed those of 1916 by 13 per cent.

It is estimated that the amount of garbage still wasted is sufficient to produce more than 30,000,000 pounds of garbage grease, 60,000 tons of fertilizer tankage and 40,000,000 pounds of pork.

The conservation of food and garbage during the war has had its effect upon the different cities over the country. Syracuse and New Orleans have had garbage reduction plants authorized. San Francisco opened bids contemplating utilization in January, 1917. Wheeling, W. Va., entered into a contract for disposal by feeding. Norfolk, Va., and Newark, N. J., are considering a number of propositions submitted to them by various corporations. The amount of garbage still available for utilization is enormous.

Disposal of Manure.—This is a very important matter whether or not it has reference to the prevention of fly-breeding around a dwelling house, camp or barracks.

It is commonly known that the house fly, Musca domestica, constitutes more than 98 per cent. of the flies found in dining halls and dwellings, and also that the eggs of the house fly are usually laid in horse manure, which shows the necessity of properly disposing of this material.

LIFE HISTORY OF THE HOUSE FLY.

The eggs are usually laid upon horse manure, although they breed in human excrement or decaying vegetables. One adult female lays about 120 eggs at a time and may lay between two and four batches during her life. Eggs hatch in from eight to twenty-four hours, and the larvæ, or maggots, issuing from them are very small and transparent. They obtain their full growth in four to five days, when the maggots appear creamy white in color. Just before pupation, the dormant state, the maggots migrate to the cooler, dry edges of the pile, burrowing into the solid or even crawling several feet from the pile in search of a cool spot. The pupæ stage lasts from three to ten days. They are barrel-shaped and dark brown in color. At the end of cubation the adult fly emerges, the wings spread and the cycle is complete, taking eight days from the time of deposition of eggs to the emergence of the adult fly. The female adult is ready to deposit eggs in three or four days in midsummer.

Thus to check the fly nuisance one can readily see that the immediate removal of manure or soil bedding from the corral or stable is most essential.

The manure may be disposed of by being taken away every morning and spread out thinly so that it will dry. Or it may be placed into fly-proof bins and held there for several days until it is hauled away.

Manure may be sprayed with hellebore, borax and acid phosphate in order to kill the maggots, and at the same time preserve the fertilizing value; but these methods are too expensive to consider when large quantities of manure are to be treated. A more practical method of disposal, and one in which it can be used as a fertilizer, is the building of the manure in compact heaps. A firm ground should be selected for this purpose, in order to check the boring of maggots. It is also useful to sprinkle ordinary road oil on the area where the manure is to be packed. In addition to compacting the sides of the pile it may be necessary to sift some powdered borax over them whenever maggots are seen.

DISPOSAL OF WASTE IN U. S. ARMY CANTONMENTS.

After much discussion in regard to the manner of waste disposal by the National Army and National Guard Camps it was decided to sell the material by contract rather than for the Government to install incinerators or reduction plants. The material was sold on the number of occupants per month of each camp. The prices received varied at the different camps, ranging from 3 to 9 cents per month per man, making an average of 5 cents. This covered all waste material, with the exception of manure. As stated the basis of sale was different at some of the camps; for instance, at Camp Travers, San Antonio, the following prices prevailed: Bones $11.00, garbage $1.90 and waste-paper $4.00 per ton, while at Camp Devens, Mass., the contractor paid

$2160 a month for all waste, including the moving of material but not the collection.

Collection of Material.—At each army kitchen were placed a number of different garbage cans with tight covers, where the material was sorted. Tin cans being placed in one, garbage in another, paper in another, etc. The cans were collected by the Government trucks and taken to what is known as a transfer station. The transfer station consisted of a building with a covered loading platform and a device for washing cans. Boilers were installed in order to have hot water for this purpose and in some instances a small incinerator was installed for the burning of rubbish. The Government trucks unload the cans from one side of the platform and the contractor hauled away the cans from the opposite side. Clean and thoroughly washed garbage cans were returned to the army kitchens. The contractor was not permitted to keep the garbage within three miles of the camp in order that there be no chance of fly-breeding by the establishment of piggeries nearby.

The disposal of manure was quite a problem, as it is estimated that there were 1200 horses at each camp, which would produce about 120 tons of manure per day. For the Government to attempt to dispose of the manure it would cost 60 cents per ton to haul and to incinerate; therefore the Government, by selling the manure, was able to make a net return of $200,000, or approximately $2,000,000 per year, plus saving the cost of construction of an incinerator and the cost of burning other material than manure, which would have added at least $120,000 more.

Dish water and slop water from kitchens were evaporated upon small incinerators constructed by individual companies. Originally these incinerators attempted to take care of the disposal of the garbage, but this was never thoroughly done.

Different types of incinerators have been recommended for use in semipermanent or permanent camps to dispose of sewage water, as well as being adapted for incineration of garbage, etc.

Palmer Incinerator.—The following is a description of the "Palmer" incinerator, designed by Capt. George T. Palmer, Sanitary Corps, after his experience in the use of a number of different types of incinerators. This type of incinerator was used at several of the embarkation camps with excellent results.

Dimensions.—The incinerator is constructed with brick walls, measures 11 feet by 3 feet 4 inches in plan and is 4 feet 4 inches at its greatest height. The evaporating and incinerating devices are entirely supported by pipes set in the walls. The incinerator is built to accommodate 4 foot cord wood as fuel.

Evaporation.—The tanks (*A*) have a capacity of 10 to 15 gallons and are filled by an attendant from a 33 gallon galvanized iron collection can into which the kitchen water and liquids from mess kits have been poured through a box screen to remove the coarser solids. Three or more $\frac{1}{2}$-inch holes fitted with wooden plugs near the bottom

of the can permit the flow of liquids from tank (*A*) to be and to run out onto the perforated trough, which is formed from the upper part of the inclined evaporating sheet (*B*). The perforations in this trough should be about $\frac{1}{2}$ inch in diameter to prevent frequent clogging and should be spaced from 4 inches to 6 inches apart.

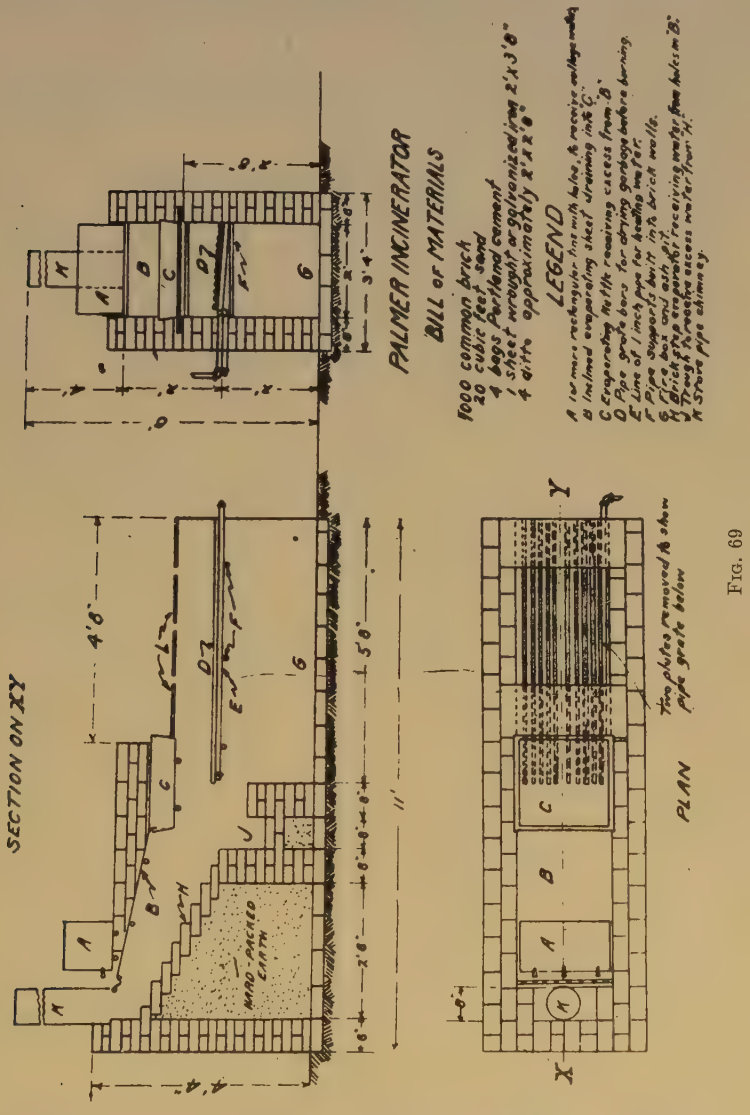

FIG. 69

Falling through the perforations the water flows down the brick steps (*H*) which form the bottom of the flue. Evaporation takes place here very effectively as the water is rapidly raised in temperature and exposed to moving heated air. The water passes off as a vapor with the flue gases.

Some of the existing liquids from tank (*A*) which will not readily flow through the perforations in the trough will flow down the evaporating sheet (*B*), and the excess flows into pan (*C*) where it is evaporated. Any water which is not evaporated on the brick steps (*H*) will flow into the trough (*J*) and remain there until evaporated by the flue gases. If this trough overflows, it will be readily known by the hissing noise in the fire box (*G*).

There is no difficulty in evaporating at least 150 gallons of liquid per day in this manner, and with careful attention and a hot fire the amount can readily be exceeded. About one-twelfth of a cord of wood is required per day.

Garbage Incineration.—The grate (*D*) is made up of 1-inch pipe laid on the heating coil (*E*) which in turn is supported by three or more pipes set into the brick walls. There should be a sufficient number of pipes about 5 feet long in the grate to allow not more than a 1-inch space between them. Garbage is placed on the grate from above by removing one or more of the iron plates (*L*). When the garbage is sufficiently dried the pipes may be spread apart by hand, thus allowing the dried garbage to fall into the fire and be burned.

The screenings from the sullage water and coffee grounds may also be disposed of on the grate.

Burning Out of Tin Cans.—The grate (*D*) may also be used for burning out tin cans, as they will be subjected to sufficient heat to incinerate any food material left in them. It is easier to add and to remove cans from this grate than from the main fire pit (*G*).

Heating Water.—The heating coil (*E*) is a single circuit of 1-inch pipe, which is attached to a barrel on the side of the incinerator. The upper or return pipe should enter the barrel about 1 or $1\frac{1}{2}$ feet from the top, whereas the lower or feed pipe leaves the barrel from 6 to 12 inches from the bottom. The barrel is placed on a stand $1\frac{1}{2}$ feet above the ground. A tap placed about $1\frac{1}{2}$ or 2 feet from the bottom of the barrel provides a convenient means for drawing hot water.

Attendance.—For efficient operation this incinerator needs the time and attention of but one man. Intelligence in the feeding of liquids and garbage and in the care of the fire will, to a large measure, determine the capacity of the incinerator.

Necessary Fuel.—Generally speaking this type of incinerator requires one pound of fuel to burn $5\frac{1}{2}$ pounds of garbage. This is in contrast to other types which require 1 pound of fuel to burn 1 pound of garbage.

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CHAPTER XVII.

HOUSING AND PLUMBING.

By ARTHUR R. GUERARD, M.D.

HOUSING.

The importance of observing the principles of hygiene in the construction of habitations for human beings is not sufficiently appreciated by the public. Architects and builders themselves have not kept pace with the sanitarian in the study of the conditions necessary to be observed in building a dwelling house which shall answer the requirements of sanitary science.

Inseparable from the question of the defective construction of dwellings is that of overcrowding and lack of proper ventilation, light, etc. The concentration of population in cities, resulting from the progress of modern industrialism has given rise to serious evils in connection with the housing of the poor. Scarcity of accommodations, coupled with high rents has resulted in a degree of overcrowding, and an exploitation of cheap and obsolete dwellings that threaten the physical and moral health of the working class.

The housing problem presents various aspects according to local conditions. In our large cities, especially in New York, its chief factor consists in undue aggregation of population upon a limited area of ground, with the resultant tendency to occupy as much of the building space as possible with lofty structures, thus depriving the tenants of adequate light and air. In European cities, on the other hand, where building operations have been less active, the evil is manifested in the form of occupancy by several persons of apartments designed for one, with consequent menace to health. The vital importance of the application of sanitary laws in the construction and occupancy of dwellings cannot be overestimated.

The housing problem at present most prominent in the public mind concerns overcrowding in the great cities, being coextensive with modern industry. Investigations carried on in New York, Chicago, London, Paris, Berlin and Stockholm tell the same story of a working population, overcrowded in houses and tenements, with resultant weakening of health, prevalence of infectious diseases and moral decay. In the United States the problem first assumed acute form in New York City. Agitation for public control of housing in New York began in 1842, but no action was taken until 1864, when a council of hygiene and public health was organized. In 1867 the first law on the subject of tenements was enacted. Its provisions, however, were entirely inadequate, and builders were practically free to follow their own

devices until the law of 1901 was enacted. This law, improved by successive amendments and efficiently enforced has done much toward improving housing conditions in New York. But it has been impossible, apparently, to overcome all the worst consequences of the earlier period of license in construction. As late as 1900 there were in New York City 1000 "dumb-bell" tenements, 20,000 houses in which most of the rooms were dark, 100,000 rooms without windows, and 1,000,000 persons without facilities for baths in their houses. None the less the condition of the tenements has been notably improved. To this improvement must, in part, be credited the decline in the death-rate from 20 per thousand in 1900 to less than 12 per thousand in 1920.

The regulation of housing in other cities received a great impetus from the New York law of 1901. In 1904, a similar law was enacted in New Jersey, and by 1912 such laws had been enacted in six other States, applying for the most part only to large cities. In 1913, 82 cities in the United States and 5 in Canada had housing regulations in force.

The housing regulations include, as a rule, restrictions upon the percentage of lot area that may be covered by a building; requirements as to cubic content of each room intended for occupation and as to light and air; regulations as to plumbing; provision of safeguards against fire, such as specifications of fireproof or slow-burning materials for buildings above a given height, non-combustible stairways, fire escapes, etc. Such regulations should be enforced through the regular police, through the local board of health, or through a special administrative organization like the Tenement House Commission of New York, the last method being essential to effectiveness.

In the case of buildings in existence at the time of the enactment of housing laws it is possible to make only limited improvements. On the grounds of public safety and health an energetic administrative board can impose certain improvements, such as the provision of fire escapes, the cutting of windows in dark rooms, and the installation of proper plumbing. The serious evils of overbuilding in respect of area lot and of improper construction cannot thus be reached.

The problem of housing the masses, particularly in larger cities, is too vast a subject to be dealt with fully in a work of this kind; but the fearful prevalence of tuberculosis in many of the tenement house districts of our great cities demands special notice. The often described "lung block" of New York, on Cherry and Market Streets, had in 1894–5 a death-rate from tuberculosis of 37.5 per cent., while the death-rate in the city at large was only 21.5 per cent. For the ten years 1894 to 1904 no less than 291 cases of tuberculosis were reported to the Department of Health from this block, yet in spite of this and repeated complaints of violation of the Tenement House Law, a long time elapsed before the lung block was finally destroyed and the space partly converted into a playground. Every collection of dark, unclean, unventilated tenements is a lung block, dealing death to those, who from economic reasons, not from choice, must live there.

Viewed from a purely utilitarian standpoint, money invested by philanthropic citizens in model tenement houses gives to the investor, as a rule, as high and higher percentage than he is apt to receive from other safe investments. There are several such enterprises in this country, involving both philanthropic and business principles, which pay the investors from 5 to 6 per cent. In New York there are the A. T. White Improved Dwelling Company of Brooklyn, who erected the Home Tower and Riverside Buildings; the Astral apartments of Pratt Institute; the Improved Dwelling Association, with model tenements at 71st Street; and the Tenement House Building Company, with property in Cherry Street. In Boston are the Harrison Avenue Estate, the Rufus Mills Memorial Building, Coöperative Building Company, and the Improved Dwelling Association. In Philadelphia is the Theodore Starr Property. The City and Suburban Company of New York City was organized in 1896 as the outcome of the Improved Housing Conference. It aims to offer a safe investment returning 5 per cent. and to provide the best accommodations for working people. Under this head the most striking development is the "Garden City Movement" which seeks to solve the housing problem by removing city workers to suburban areas. This plan has been tried with some success both in Europe and America. An example of the movement in this country is the community established at Forest Hills, L. I., by the Russell Sage Foundation.

But important as philanthropic efforts at housing reform really are, it is easy to exaggerate their influence upon the general housing situation. According to estimates of Veiller, in the years 1862–1901, 25 groups of tenements, accommodating 3588 families were erected in New York under philanthropic auspices; 27,100 tenements, accommodating 253,510 families were erected by speculative builders. In the years 1902–1908 the philanthropic enterprises provided accommodations for 1871 families, while speculative enterprise provided for 253,255 families. It is thus evident that even a slight improvement, imposed by public authority upon the mass of speculative builders may contribute more to the solution of the general housing problem than the aggregate of philanthropic endeavor. Health officers and sanitarians should concentrate their efforts upon improving the housing regulations and securing their efficient administration.

Type of Dwelling.—The general types of dwellings concerned in the housing problems are: (1) One-family dwellings; (2) two-family dwellings; (3) tenements. The promotion of the one-family dwelling is one of the main objects of housing reform—detached houses, each with its own plot of ground—such as have been developed in various cities with considerable success. Two-family dwellings may also be quite satisfactory under certain conditions. This class of house may be arranged either as a double house with a party wall between and separate entrances on each side, and each family occupying one-half the house; or as a single house in which one family occupies the ground floor and basement, and a second family occupies the second and third

floors, with separate entrances for each family. The tenement house is one in which more than two families dwell independently, but sharing common hallways (though there are various definitions under different local laws). It is against this class of dwellings that most of the housing reform has been directed, as above indicated.

Essential Requirements of a Healthful Private Dwelling.—In order to be healthful a dwelling should fulfill the following requirements:

1. It should be dry and free from dampness, be well drained, and have the ground air excluded from it.
2. It should be well sewered, so that all liquid waste matters are nowhere stagnating, but are immediately and completely removed.
3. It should have a sanitary system of plumbing, pipes, fixtures and fittings.
4. It should be well lighted, and have as much sun exposure as possible.
5. It should have an ample supply of pure water, flowing under a good pressure and protected in the house from all possible sources of contamination.
6. It should be properly ventilated, and be supplied with pure air in all parts.
7. It should be kept clean and free from any nuisances.
8. It should have healthful surroundings.

Location and Site.—The site of the dwelling should be dry. It should be protected, if possible, against violent winds, although a free circulation of air all around the house should be secured. Close proximity to cemeteries, marshes and injurious manufacturing establishments or industries must be avoided. A requisite of the greatest importance is the ability to command an abundant supply of pure water for drinking and other purposes.

Soil.—The soil should be porous and free from decomposing animal or vegetable matter or excreta of man or animals. It should be freely permeable to air and water; the highest level of the ground water should be nine or ten feet of the surface, and the fluctuation of the ground water should be limited. It is impossible to say positively that any kind of soil is healthy or unhealthy, merely from a knowledge of its geological character, as the accidental modifying conditions such as organic impurities, moisture, the level and fluctuations of the ground water are of much greater importance than the geological formation of the soil. But as a rule, sites on granite, metamorphic and trap rocks, clay, slate, sandstone, sand and gravel are usually healthy. Limestone, clay, dense marls and alluvial soils generally are to be regarded with suspicion. Cultivated soils are often healthy, nor has it been proved that the use of manure is necessarily hurtful.

Where wet, impermeable or impure soil must, of necessity, be chosen as a building site, it should be thoroughly drained. The minimum depth at which drains are laid should be not less than four feet below the floor of the cellar or basement. Such soil should be covered with a

thick layer of asphalt-cement under the house in order to prevent the aspiration of the polluted ground air into the building.

It is a common custom in cities to fill in irregularities of the building-site with street sweepings and garbage, which always contain large qualities of decomposing organic matter. This is a violation of the principles of hygiene. It is undesirable to use such decaying or putrefying organic material for the purpose of grading streets in cities and towns. It should be the constant endeavor of all health officers to prevent the pollution of the soil as much as possible in towns and villages. The separation of the garbage from the ashes yields a suitable material.

Where houses are built on the declivity of a hill, the upper wall should not be built directly against the ground, as it would tend to keep the wall damp. A vacant space should be left between the wall and the ground to permit free access of air and light.

As regards trees in country sites, it may be said that, while it is true that they give shade in summer against the sun, and shelter in winter against raw winds, they must not stand too near a dwelling. If so, they darken the rooms, prevent the entrance of sunlight, deprive the house of proper currents of air and promote dampness of the walls.

Building Material.—The nature of the most suitable building depends upon so many varying circumstances that no definite rules can be laid down. Generally speaking, however, moderately hard burned brick is the most serviceable and available. It is easily permeable by the air, and so permits natural ventilation through the walls, unless this is prevented by other means. It does not absorb and hold water readily; hence damp walls are infrequent if brick is used. It is probably the most durable of all building material. On account of its porosity a brick wall is a poor conductor of heat. It therefore prevents rapid cooling of a room in cold weather, and likewise retards the heating of the inside air from without in summer. Another very great advantage is its resistance to a very high degree of heat, brick being perhaps more nearly fireproof than any other building material.

Next to brick, granite, marble and sandstone are the most serviceable building materials. Very porous sandstone is, however, not very durable in cold climates, as the stone absorbs large quantities of water, which, in consequence of the expansion due to freezing, produces a gradual but progressive disintegration.

In hot climates light wooden buildings are advantageous, because they cool off very rapidly after the sun has disappeared. On account of the numerous joints and fissures in a frame building, natural ventilation goes on very steadily and to a considerable extent.

The application of paint to the walls, either within or without, checks the transpiration of air through the walls, thus limiting natural ventilation. Calcimining, on the other hand, offers very little obstruction to the passage of air. Wall paper is about midway between paint and lime-coating in its obstructive effect.

Newly built houses should not be occupied until the walls have

become dry. Moisture in the walls is probably a not infrequent source of ill health; it offers favorable conditions for the development of disease germs, and, by filling up the pores of the material of which the walls are composed, prevents the free transpiration of atmospheric air through them.

Moisture of the walls is sometimes due to ascent of the water from the soil by capillary attraction. This may be prevented by interposing an impervious layer of slate, etc., in the foundation wall.

Arrangement and Size of Rooms; Ventilation and Heating Arrangements.—If possible, attention should be given in grouping the rooms of a house to the question of aspect or outlook. Living rooms should front toward the south or southeast; the principal bed-room may have an outlook toward the east or northeast, thus getting the morning sun. A dining-room may look toward the north, northeast, or northwest, while the domestic quarters will usually be located on the west or northwest side of the dwelling.

A house in general should be so placed as to get the greatest amount of sunlight to the interior. All rooms should be airy, sunny and well lighted. Nothing is so detrimental to domestic cleanliness as darkness. Every room of the house should have large, outside windows, reaching well up to the ceiling. Roofs of wide porches or piazzas are delightful sheltering places in the country against the hot sun of summer, but they rob the lower rooms of much necessary light. Shutters and blinds are desirable in some places to keep out too much sun, but they must not be kept closed all day.

The windows and doors should be screened during, at least, a part of the year, in order to prevent the entrance of flies, mosquitoes and other insects. Screens are particularly desirable for the bedroom of the house and also for the dining-room, the kitchen and the pantry. This is not only a question of convenience and comfort, but one of health. Both flies and mosquitoes are carriers of disease; the screening of houses is therefore to be considered as a sanitary measure of infinite importance. But besides the window and door screens to keep out these insects, it is necessary that more radical efforts should be made to destroy flies and mosquitoes where they breed.

Flies breed mostly in manure. All the manure from horse stables should be treated with lime or kerosene and kept in securely closed pits, in country places, and frequently removed. Privy vaults and cesspools should be treated also. Dirt and accumulations of any kind around a house should be abolished, and in this way much can be done to mitigate the evil. The maintenance of absolute cleanliness inside of houses is of the greatest assistance. In cities the reduction in the number of horse stables and the increasing use of automobiles, motor cycles, and electric cars help very materially in the fight against flies.

In the same way, through the use of window and door screens, and of mosquito nettings over the beds is desirable, it is of much more importance to destroy the breeding places of mosquitoes. All cisterns,

rain-water barrels, water tanks and cesspools about the house should be well screened. All stagnant pools of water should, whenever possible, be drained or filled in, or else these places may be treated with kerosene oil to destroy the larvæ. In ponds and pools of clear water the introduction of small fish, which feed on the larvæ, is recommended.

As to the *size of rooms* in a dwelling, no room should be less than eight or nine feet in height. The sleeping room should be large; it should never contain less than 1000 cubic feet of air space for adults, and 750 cubic feet for children under ten years of age, and provision must be made for changing this air sufficiently often to maintain it at its standard of purity. Details for accomplishing this will vary with the architect's design, the material of which the house is constructed, the climate, and the season. The principles laid down in the section on ventilation should be followed.

In cold weather the air should be warmed, either before its entrance into the room or afterward, by some form of *heating apparatus*, fireplace, stove or furnace. The details of the heating apparatus are given elsewhere, and they may be left to individual taste or other circumstances. It may be noted, however, in passing, that the prevailing method of heating houses by means of hot air is objectionable for various reasons; partly because the air is too dry to be comfortable; partly because organic matter is frequently present and gives to the air an offensive odor when the degree of heat is high enough to scorch the organic matter. Both of these objections are, however, removable if care is taken to supply artificially the necessary amount of moisture, and to have the furnace large enough so that the temperature need never be raised to a very high degree. Heating by hot water or steam obviates the latter objection, but not the former, and unless special provision is made to let fresh air into the room from outside, the inside air is reheated. Moreover, both hot water and steam heating methods necessitate a more expensive heating system.

Some form of *artificial light* will also be needed in all dwellings. Certain dangers are necessary accompaniments of all available methods of artificial illumination. The danger of fire is, of course, the most serious. This danger is probably least where candles are used, and greatest where the volatile oils (kerosene, gasoline) are employed. The use of candles is seldom resorted to at the present time except to give extra light temporarily, or for the decoration of the dining table. For general illumination the use of candles also results in pollution of the air by carbon dioxide and other products of combustion to a greater degree than when other illuminating agents are employed; they give out, too, a larger amount of heat in proportion to their illuminating power. Kerosene oil yields a good light when burned in a proper lamp, and is cheap, but the dangers from explosion and fire are considerable. The danger from explosion can be greatly reduced by always keeping the lamp filled nearly to the top and never filling it near a light or fire. The danger of explosion is increased when the chimney of the lamp is broken, as then the temperature of the metal collar, by which the

burner is fastened to the lamp, is rapidly raised and the oil is vaporized, forming an explosive mixture of air and the vapor of the oil.

The use of *coal-gas* is probably attended by less danger than the lighter oils, but by more than other means of illumination. In addition to the danger from fire and explosion, which are inevitable accompaniments of defects in the fixtures, the escaping gas is itself very poisonous from the large amount of carbon monoxide it contains. That variety of illuminating gas known as "water-gas" is more dangerous to inhale than coal-gas owing to the greater amount of carbon monoxide in it. The "natural gas" used as a fuel and illuminant in some places in the United States is especially dangerous from the total absence of odor.

The danger in the use of illuminating gas arises from two sources: (1) from unburned gas which escapes into the atmosphere through defective pipes or fixtures, or through burners accidentally open, and (2) from vitiation of the atmosphere through the products of burning gas. The National Board of Fire Underwriters has published a table of gas losses which shows that over 14 per cent. of the total product of gas plants leaks into the streets and houses of cities supplied. The danger to houses from escaping gas is much greater in the winter time, when the street surface is frozen, and when houses, on account of their higher temperature, act as chimneys to draw in the ground air, and with it the gas that has leaked into the soil. Gas thus escaping may follow water or sewer pipes and enter even those houses which have no gas connections. In order to remove the constant menace to life and property, through explosion and asphyxiation, which is afforded by leaky gas mains, the whole matter should be under the strictest surveillance and control by the public authorities. The introduction in our large cities by subways for underground pipes and wires would remedy the evil by rendering gas mains easily accessible for constant inspection. In this way the slightest leak would be detected, and the danger of deterioration of the main through rust and of their breaking through settling of the soil would also be removed.

For cases of *isolated lighting*, as in country houses, etc., air gas, oil gas, and acetylene are chiefly used. Among these the oldest method is air gas, popularly known as "*naphtha gas*," which consists of air charged with naphtha or gasoline vapor. If the product is to be used exclusively for house lighting and heating, care must be taken that the mixture contains either less than 2 per cent. or more than 5 per cent. of the hydrocarbon vapor, as it is between these figures that the mixture is explosive and only fit for use in the gasoline engine. Where the mixture consists of more than 5 per cent. vapor, it must be mixed with air before combustion. Such mixtures are now used almost exclusively for heating purposes and are familiar in the painter's or brazier's torch and plumber's furnace. Either piece of apparatus consists of a strong brass cylinder provided with an air pump or heating coil and a burner tube filled with fibrous material, the outer end of which terminates in a needle valve for controlling the supply of heated gas, and an air-mixing chamber. Of the few types of apparatus of this order still used

for house lighting, the simplest consist of a revolving air-drum driven by weight and capable of forcing warm house air through a pipe to an underground tank, situated some distance (50 feet) from the building. This pipe enters the top of the tank, bends at right angles, and continues nearly to the bottom. Another pipe for conveying the vapor-laden air leaves the top of the tank and returns to the building. A supply pipe for gasoline extends just above the ground line and is closed except when the tank requires filling. It is obvious that the house air, impelled by the drum, bubbles through the gasoline and becomes saturated with vapor. Special burners, filled with fiber provided with an air-mixing device, are necessary, and incandescent mantles are used to give a brighter light. Many forms of air-gas machines are now operated by gasoline-engine power, the exhaust from which heats the air used in the operation, thus obtaining more constant results. A simple form of apparatus of the pressure type is quite largely used in small household stoves and differs not materially from the plumber's furnace, except that the air pump is absent.

Oil gas or illuminating mixtures made by the destructive distillation of oil or fats, antedates coal gas, but failed from high cost of the original material. With the production of cheap liquid hydrocarbons from various sources, the project revived and is now extensively employed for enriching water gas or to be sold in a compressed form for isolated lighting—railway cars, boats, buoys, country dwellings, and street lamps. This gas is best known as "Pintsch gas."

Acetylene (C_2H_2) is produced by adding water to calcium carbide or *vice versa*. The gas is pure, requiring no further treatment, and the operation of making may be stopped at will. As this gas is generated under pressure, a strong well-made apparatus is necessary, and there is always the element of danger from excessive pressure. This form of lighting has been very popular, especially on a small scale, as in bicycle and automobile lamps, etc., and also for house illumination of isolated dwellings. Acetylene burns best in the Y-shaped burner. The apertures are in the inside of the Y arms near the top. The two opposing streams of gas impinging spread out in fan-shaped flame and yield a brilliant steady white light. Acetylene is less poisoning than any other illuminating gas, and if it escapes in any quantity may be recognized by its characteristic odor. There are numerous acetylene generators in the market; of the various types, those in which the carbide is fed into the water are considered the best. Some underwriters require the machine to be placed in a frostproof out-building, at some distance from the house; others permit locating the generator in the basement or cellar. None should be used except one approved by the underwriters.

The *Edison incandescent electric light* is probably open to less objection on the score of danger than any other of the illuminating systems mentioned. There is no trustworthy evidence that the electric light has any unfavorable influence on the vision. The advantages of the electric light, besides the brilliant white light it gives, are that it is steady and does not produce any heat, nor does it pollute the air with

carbon dioxide and other products of combustion. Incandescent lamps are usually designated as carbon, metallized carbon, tantalum, or tungsten lamps, according to the nature of their filaments. With the general adoption of tungsten metal as a filament material, the use of carbon filaments has very greatly declined. In some tungsten lamps of recent development a radical departure is made from all previous practice by filling the bulb with nitrogen gas. It has not been found possible, however, to improve the efficiency or life of small lamps by this method; hence its commercial development is limited to lamps above 100 candle power. With the development of modern illuminants of high efficiency, much attention has been given to the artistic and scientific use of lamps. High efficiency lamps are for the most part of excessive brilliancy and require the use of some kind of diffusing medium to soften the light. In many cases a degree of diffusion approaching that of daylight has been sought by the complete concealment of the lamps within bowls or troughs which reflect the light upward to a white ceiling, whence it is distributed about the room. Semi-indirect lighting, in which the lamps are covered by transparent bowls of glass, which partially transmit the light downward and partially reflect it to a white ceiling, is considered by many a more satisfactory solution of the problem.

Electric lighting is somewhat safer than gas or oil lamps as regards danger from fire, but it is so only if all rules and precautions advised by underwriters are strictly followed and observed. The wires should never be run in wooden mouldings, but must be carried in iron or brass "armored" conduits. The entire house installation must be tested by an expert electrician to guard against defects. In isolated lighting by electricity the plant may be located in the barn or in the water pumping station, if there is one, and comprises an engine or power motor (gasoline or oil engine or water power) and a dynamo or generator. In some cases storage batteries are installed in connection with the dynamo, insuring a steadier supply of electric current.

WATER SUPPLY AND PLUMBING.

The water supply of a dwelling should be plentiful for all requirements, and its distribution should be so arranged that the supply for every room is easily accessible. When practicable, water-taps should be placed on every floor, both for convenience and for greater safety in case of fire. It is also the result of experience that personal habits of cleanliness increase in a direct ratio with the ease of obtaining water. The inmates of a house where water is obtainable with little exertion are much more likely to be cleanly in their habits than where the water supply is deficient or not readily procured.

Plumbing.—In its broadest sense, plumbing includes the pipes and fixtures within houses used to supply water, gas, and heat, and also the pipes used to remove liquid waste from buildings. A more restricted and more common use of the term includes only the water supply and

house drainage system, leaving gas fitting and steam and hot water fitting in two separate classes—and it is in the former sense that it will here be considered.

Supply.—The pipe leading from the street main to the building is called the house connection or service pipe and is frequently laid, at least as far as the curb or sidewalk line, by the water department. The service pipe, and the water pipe system within the house as well, may be of lead or wrought iron, or, if the building be large, the main piping may be of cast iron. In highly finished, expensive work, brass or nickel-plated pipe is sometimes used, and copper may be employed for hot water piping. As some waters slowly attack and decompose lead and give rise of lead poisoning, the materials for service and house piping should be chosen with care. A valve at the sidewalk enables the water department to turn on or shut off the water to the consumer at will, and another valve, just inside the cellar wall, permits the householder to control the house supply from that point on. The water meter, if employed, is generally placed just inside the latter shut-off valve. Except in the smaller and cheaper houses the water piping is mostly in duplicate, one set of pipes being for hot and one for cold water. The water is heated by circulating through a pipe or a water boiler at the rear of the kitchen range, from which it goes for storage to the kitchen or range boiler. Where large supplies of hot water are used a separate heater fired either by coal or gas may be employed, and in the latter case the burner is regulated automatically. These hot water boilers are made of wrought iron, steel, or copper, with riveted joints, and should be tested to withstand a high pressure. When the water supply is liable to be inadequate at times, or when the direct pressure is too heavy for safety to the plumbing, a tank is provided in the upper part of the building, and in a sky-scraper there may be several sets of these tanks at different elevations. Tanks for the fire lines are often required for large buildings. Great care is necessary to secure and maintain water-tightness. Tanks must be provided with automatic valves to insure a constant supply therein and to prevent water going to the tanks when full; also with overflow or waste pipes.

Fixtures.—*The various faucets, sinks, and other similar appliances connected with a plumbing system:* Faucets, cocks, or valves are provided at each place where water is to be drawn. It is important that these should be of high grade to prevent leakage. Sinks are provided in the kitchen, the butler's pantry, and in large houses and semi-public and public buildings, in various other places. Most commonly they are of iron and have hot and cold water. Laundry tubs are placed in a separate room or in the kitchen, and consist of two or more rectangular compartments, with the front side sloping, provided with hot and cold water and composed of soapstone, artificial stone, cement, iron, earthenware, porcelain, or other material, with or without hinged covers. The chief essential in the material for laundry tubs is lack of porosity; wood, on account of its high absorbing quality, is unsuitable. Set washbowls are provided in bath-rooms and lavatories, in the private rooms of

hotels, and sometimes in the sleeping rooms of private dwellings. At one time they were most commonly of marble, but cast iron and steel, both painted and enameled, and porcelain are now more generally employed. Bath-tubs, once generally constructed of polished sheet copper, formed on wood, or of solid copper, are now made of enameled cast iron and of porcelain. Shower baths, sitz baths, and foot baths are sometimes added for the special purposes indicated and are made of different designs and materials. Water-closets, so called because matter deposited into them is flushed out by a discharge of water, are most commonly of glazed earthenware, although in cheap work cast iron is sometimes used. The old-fashioned pan water-closet was one of the most unsanitary of all plumbing fixtures. It consisted of a metal pan, hinged so as to drop downward and discharge its contents into the

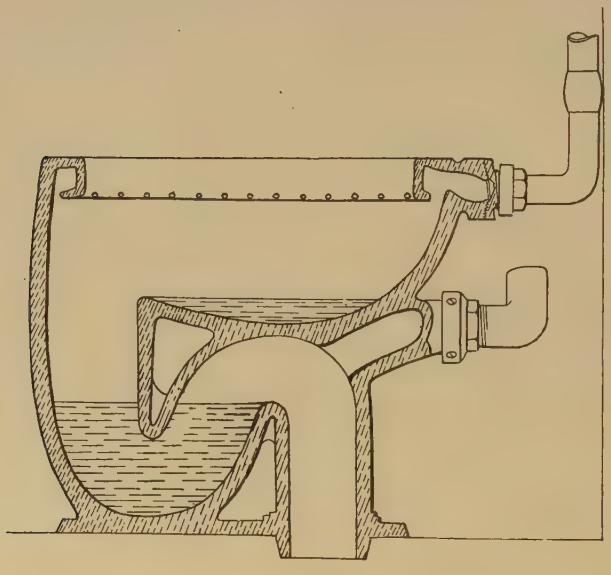

FIG. 70.—Open wash-out closet. (Harrington.)

pipe with which it was connected. The valve and plunger closets, operated as indicated by their names, were but little better, and are also out of date. Most of the improved forms of water-closets now in use depend for their action upon the sudden discharge of a few gallons of water, generally from a tank located above the closet. The discharge is usually effected by pulling a hanging chain attached to a lever and valve. In the case of closets in public places the tanks may discharge automatically. Recently, however, attachments have been introduced for flushing water-closets without the use of a tank, the water supply being controlled by a valve operated by a short lever, near the closet seat. In either case the water thus liberated displaces the water previously standing in the bowl or hopper of the closet or else sets it in motion by siphonic action, carrying the wastes with it. By this means

the closet is kept fairly clean, particularly the most exposed portion, and the parts not thoroughly clean are always wet. Water-closet flush tanks are generally of wood, lined with copper and provided with a float valve, a water supply and a flush pipe. There is an almost endless variety of water-closets. Urinals are provided in public places and consist of either bowls or vertical slabs of non-porous material inclosed in stalls and provided with flushing water. Latrines are a series of water-closet stalls connected with a long trough or common flushing chamber below. They are employed chiefly for barracks and institutions. Sill or hose cocks are faucets or valves, with a provision for attaching hose, provided at convenient points for sprinkling lawns, etc.

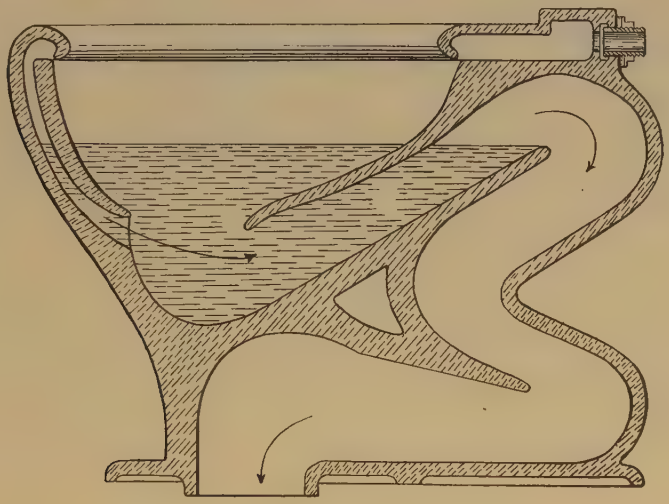

FIG. 71.—Siphon jet closet. (Harrington.)

House Sewerage or Drainage.—This includes everything required to remove fouled water from the house to the sewer. The pipes from each separate fixture are known as waste pipes; they run to one or more soil pipes, the soil pipe being the vertical run of pipe from the highest fixture to the cellar; the *house drain* extends from the foot of the soil to a point near the cellar wall, and the house sewer from the latter point to the street sewer. Waste pipes, particularly short runs from wash-bowls and minor fixtures, may be of lead, but, generally speaking, cast or wrought iron is preferable for important wastes. All soil pipes and the house drain also should be of cast iron. Heavy pipe should be used throughout. The house sewer should be of extra heavy iron through and a short distance beyond the foundation, after which vitrified clay pipe is permissible. All soil and waste pipes should be carried up through the roof. Traps are placed below each fixture and a main trap is generally set just inside the cellar wall. All main traps should have fresh-air inlets or a pipe extending from the inner end of

the trap to the outer air. This provides for a circulation of air through the house drain and soil pipe. An increasing number of sanitary engineers favor the omission of the main trap, thus insuring a thorough ventilation of the house and street sewerage system through the

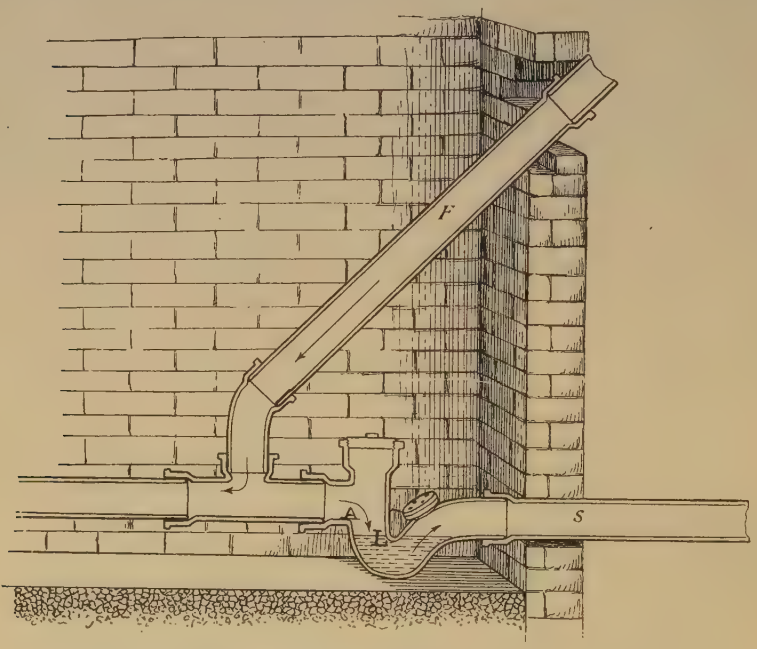

FIG. 72.—Preferable arrangement of intercepting trap and ventilating pipe. (Harrington.)

numerous soil pipes at one extremity and the street manholes at the other. The object of the trap is to prevent foul air from the house or street sewerage system from entering the house. To this end the simplest and most common practice is to form a water seal by making a bend in the pipe, shaped like the letter U called the U-trap. *Bell-*

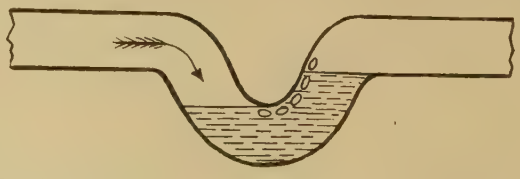

FIG. 73.—Forcing of seal of running trap. (Harrington.)

traps are formed by inverting a bell or cup over the upper and open end of a pipe, the whole being adjusted so that the edge of the pipe is always submerged. *Grease traps* may be described as enlargements on waste pipes to retain grease instead of allowing it to pass on and

clog sewers. They are most commonly used on the water or drain pipes of large kitchens. Vent pipes were formerly run from the back of each trap to a connection with the outer air, to give a back air pressure on

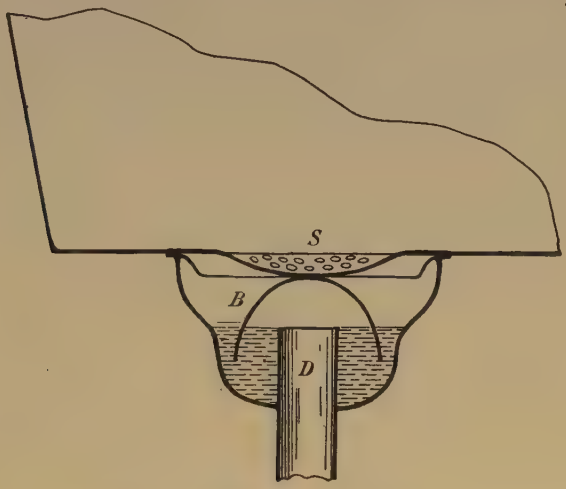

FIG. 74.—Bell trap. (Harrington.)

the trap and lessen the danger from siphonage; trap vents are now omitted on much of the best work in the United States, as they complicate the plumbing system. Regarding the omission of both main traps

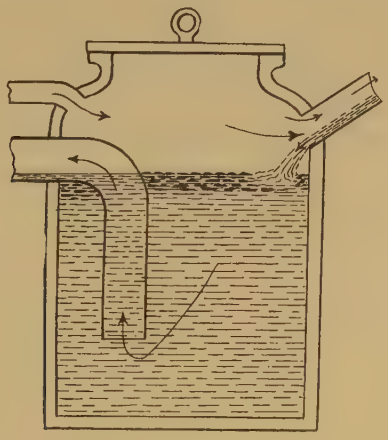

FIG. 75.—Grease trap. (Harrington.)

and trap vents it may be said that there is little need for them on well designed and built house and street sewerage systems, provided that non-siphoning traps are employed and the disposition of fixtures does

not necessitate long branch wastes without the aëration obtained from the vent pipe.

In general, simplicity, accessibility, a high grade of material throughout, heavy weight for pipes, and good workmanship are essentials of plumbing. To secure these, plumbing should be designed only by the most competent sanitary engineers and should be under the rigid supervision of efficient municipal inspectors. All plans for plumbing should be filed with the plumbing inspectors or local health department. The hydraulic pressure test should be applied when the rough plumbing has been completed, and the smoke or peppermint test when the fixtures are set.

Water closets presuppose an abundant supply of water. Unless this can be obtained and rendered available for flushing the closets, soil pipes, and house drains, the dry-earth or pail system should be adopted. Privies should not be countenanced.

The inspection of plumbing entails chiefly provision against leaking around water-closets, sinks, etc. Sewer gas, once a hygienic bugaboo, is now not seriously regarded by sanitarians.

CHAPTER XVIII.

THE SANITATION OF SWIMMING POOLS.[1]

By WALLACE A. MANHEIMER, Ph.D.

Swimming-pool sanitation has assumed importance with the recognition of the danger of swimming in polluted water and with the ever-increasing number of swimming pools throughout the country. According to conservative estimates, there are upward of fifteen thousand swimming pools in the United States, exclusive of open air, salt water and wading pools.

The problem of swimming-pool purification is largely the same as that of drinking-water purification, but differs from the latter in at least one important particular. In the purification of a water supply an initial treatment is usually sufficient, while in a swimming pool having a constant source of pollution a continuous method of purification has been found necessary.

DISEASES TRANSMISSIBLE THROUGH SWIMMING IN POLLUTED WATER.

Atkin[2] divides diseases transmissible through swimming pools into three classes, namely, intestinal, eye and ear, and venereal. To this there should be added a fourth class namely, respiratory.

Intestinal.—Klein and Schütz[3] reported cases of typhoid fever in six soldiers who had bathed in water close to the mouth of the city drainage canal. In the discussion of a paper by Maier,[4] Dr. Reece reported the occurrence of 34 cases of enteric fever among soldiers who had bathed in a swimming pool which derived its water from a sewage-polluted river. About 10 per cent. of the men using the pool became infected, while only one case developed among those who did not use the pool. The epidemic ceased when bathing in the pool was discontinued.

In Japan, Shiga investigated an epidemic of 413 cases of dysentery in the village of Nutaknura. Near the town was a river in which bathing had been prohibited. When this restriction was removed hundreds of persons went swimming, and within four days the epidemic broke out. It was found that the clothes and bedding of a person who had died of the disease had been washed in the water of the

[1] From the Research Laboratory, New York City, Department of Health.
[2] Proc. Illinois Water Supply Assn., 1911, iii, 33.
[3] Wien. med. Wchnschr., 1898, vi, 238.
[4] Proc. Med. and Chir Soc., London, 1908, ii, 227.

stream a short distance above the village. Shiga concluded that the epidemic was due to the ingestion of the river water by the bathers.

Eye and Ear Infections.—Infections of the eye and ear are quite common, as can be attested by the experience of all who have managed swimming pools. Fehr[1] tells of 20 cases of eye infection among patrons of a public swimming pool, and in one case reinfection as a result of subsequent swimming in the same pool. Schultz[2] reported 18 cases of eye infection among the young men who had used a public swimming pool which had been contaminated by an attendant who had sore eyes.

Venereal Diseases.—Skutch[3] had reported an epidemic of gonorrheal vulvovaginitis which had spread to 236 girls in a school at Posen. They all had used the same swimming pool, but not the same towels, soap, etc. Paul Bending has given an instance of 15 cases of gonorrhea among forty girls who were sent to a brine bath for medicinal treatment. The infection came from an eight-year-old girl who apparently had been suffering from gonorrhea for several years. The disease was spread through indiscriminate bathing in one bath tub and the use of a common bath towel.

Respiratory.—Epidemics of coryza among the users of swimming pools are not uncommon. It was indeed just such an epidemic which led Burrage[4] to undertake studies of methods to purify pools. Lewis,[5] Whipple[6] and others have further advanced evidence that infections of the respiratory tract can result from bathing in contaminated water.

CONSTRUCTION AND EQUIPMENT.

We are not interested here with the engineering problem of swimming-pool construction. On the sanitary side, however, certain details become of obvious importance.

Drainage.—The floor surrounding a swimming pool should be constructed of material impervious to water and so arranged that all water will drain into the sewer and not flow back into the pool. The edge of the pool should be protected from drainage water, either by a ledge or by a drainage groove. The perimeter of the pool should be provided with a surface overflow, so that debris on the surface of the water will flow off, and as an additional precaution against floor drainage.

Materials of Construction.—Stone, marble, cement, painted sheet steel, and porcelain, or enamel brick and tile have been used in pool construction. Recently certain types of surfacing materials have been used with success and have reduced the cost of construction considerably. The requirements of materials in pool construction are: (1) light

[1] Berl. klin. Wchnschr., 1900, i, 37.
[2] Ibid., 1899, xxxix, 36.
[3] Centralbl. f. Bakteriol., 1892, xii, 309.
[4] Proc. Indiana Acad. of Sc., 25th meeting, 1909.
[5] Engineering News, 1911, lxv, 689.
[6] Municipal Jour. and Engineer, 1911, xxx, 577.

color, preferably white (so that a submerged person can readily be seen); (2) smooth or easily cleansable material; (3) imperviousness to water; (4) durability.

For the floor surrounding the pool besides the materials mentioned above, cork, inlaid linoleum, wood-lattice and even rubber, have been used. A water-tight material is best, but some method to prevent the slipping of bathers is usually considered necessary. An ideal material for both floors and pool lining would be one that is durable, light colored, impervious to water, a poor conductor of heat, and surfaced, so as to prevent slipping. So far as we know no such material is on the market at the present time.

Equipment.—Descending ladders and stairs should be built into the pool so as to present no obstruction in the water. Life rails where provided should be of non-corrosible material and should be placed just at the surface of the water. With the application of surface overflow gutters, life rails have been replaced by a combination overflow ledge and life rail. This is usually made of terra cotta, although metal gutters are occasionally used.

Shower Baths.—An adequate number of shower baths, provided with hot water (except in outdoor baths where cold water is sufficient), should be supplied. In indoor pools used by women, shower baths should be placed in compartments where privacy during bathing can be maintained. The shower head should be directed at an angle. Partitions need not be higher than seven feet, but should be covered with durable wide-meshed wire. The impact, heat and friction of the water should be upon uncovered skin. The strongest agreeable pressure of water is the most efficient. Thermoregulation of the hot water (not to exceed 110° F. when it leaves the engine room) is necessary to prevent scalding. The showers taken by swimmers prior to entering a pool are hardly sufficient to wash from their bodies the harmless saprophytes that are on the skin and are ineffective in cleansing the perineal regions. For this purpose a douche from below might be satisfactory. So far as the writer knows no arrangement of this kind has been devised.

Central control of the water supplied to the shower baths is necessary in handling large crowds. By turning the water on and off at regular intervals the dressing-room compartments and the showers can be emptied and thus used to the maximum capacity.

Filters.—A proper filtering plant is of prime necessity in all indoor swimming pools. Even when the water from the mains is initially clear it is usually desirable to install a filter for the purpose of recirculation or refiltration of the water. Any type of filter that will remove suspended matter from the water is usually satisfactory. Occasionally, however, it is necessary to bleach the water to prevent discoloration of the pool.

Refiltration is used in swimming pools as a matter of economy, and when in conjunction with proper methods of water purification is an excellent sanitary measure. Water and coal for heating are saved

by refiltration and the water maintained clearer than can usually be accomplished by initial filtration. The process of refiltration has proved so valuable in pool administration that it is now properly considered a standard procedure. Clear water in swimming pools is very necessary to prevent drowning, since in dark waters submerged persons cannot be seen. A number of accidental drownings have occurred in pools where unfiltered water was used.

Concerning the rate of filtration with mechanical filters a rate of two gallons of water per square foot of surface area of filter bed per minute is usually recommended for the clarifying of muddy and contaminated waters. In actual practice, however, in swimming pools where water purifying devices are used in conjunction with filtration, a rate of three gallons can be handled with success. In general the highest rate of filtration which will remove suspended matter from the water may be used in swimming-pool filtration providing some system of water purification is also employed.

CONTROL OF BATHERS.

Where possible, bathers should be given periodical physical examinations for the purpose of excluding the diseased. In colleges and associations where a regularly registered body of people use the pool such examinations can be readily conducted, but in public swimming pools greater difficulties exist. For municipal baths, Manheimer has suggested organization and registration of the patrons, or the presentation of admission cards to be issued by the department of health after physical examination. The examinations given prior to the issuance of the card could be conducted on the general plan of that for the licensing of food handlers in the city of New York.

In addition to medical supervision of bathers, signs should be posted and steps taken to instruct all of them in the proper use of the pool, *e. g.*, the length of time to remain in the water, the necessity for preliminary shower baths in the nude, using soap, the importance of emptying the bladder before entering the pool and of abstaining from expectorating into the water, etc.

Patrons should be compelled either to bathe nude or to wear sterilized bathing costumes provided by the establishment.

MANAGEMENT OF THE WATER.

Source of Water.—It is obvious that the water supplied to a swimming pool must be pure or be purified before use. Nevertheless inferior water is frequently used in swimming pools, as shown by Manheimer[1] in examinations of thirty-five swimming pools in various parts of New York State. Lake, river and creek water containing considerable amounts of sewage were used in eight out of the thirty-five pools studied.

[1] Am. Phys. Ed. Rev., 1912, xvii, 669.

Refilling.—The early writers on swimming pool sanitation, have dwelt almost exclusively on the importance of frequent refillings. Present writers on the subject emphasize the value of dilution and refiltration.

Dilution and Refiltration.—The practice of adding warm filtered water while the swimming pool is in use is now quite common. The efficiency of this method of pool purification cannot be doubted, but it is extravagant of coal and water. Refiltration and continued use of the pool water has gradually supplanted the practice of adding fresh dilution water.

As early as 1905 Fürth and Schwarz began investigations on refiltration. Kister and Fromme,[1] who review their data, highly recommend refiltration, not only as a method of water and heat conservation, but as an excellent sanitary measure.

Disinfection.—Among the first attempts in this country at the chemical purification of swimming-pool water was that of Stokes,[2] who used copper sulphate in a Baltimore swimming tank. Alexander,[3] in 1909, reported satisfactory results from the use of magnesium hypochlorite. During the last few years a great deal of experimental work on swimming-pool disinfection has been reported. The obvious importance of this subject, together with the conflicting information published, has made necessary a critical study of the efficiency of various methods in use.[4]

Copper Sulphate.—Copper sulphate, as already stated, was the first chemical used to purify a swimming pool. Stokes used one part of $CuSO_4$ to 100,000 parts of water, which resulted in the reduction of bacteria and destruction of algæ. Soon after, calcium hypochlorite displaced all other chemicals in pool purification and is now the most generally applied chemical for that purpose.

Calcium Hypochlorite.—This has been used more extensively for pool purification than any other chemical. It is inexpensive, and under conditions of proper application is very reliable as a disinfectant. A concentration of one part of hypochlorite to 1,000,000 of water has proved to be the most satisfactory amount to add to the water.

Concerning the method of adding the chemical to the water, Manheimer[5] has found that the best results will be obtained when the chemical is added in a single dose, while with copper sulphate, continuous gradual addition from a mixing chamber proved superior.

Although calcium hypochlorite has proved to be one of the most efficient chemicals for use in swimming pools, there are certain objections to it, however, which must be considered: (1) The chemical itself is unstable. This would not be a serious objection if the various swimming-pool authorities had laboratory equipments and laboratory

[1] Kister and Fromme: Gsnhts. Ingenieur, 1910, xxx, 30.
[2] Am. Med., 1905, x, 1075.
[3] Scientific Am. Suppl., 1909, lxviii, 1765.
[4] Manheimer: Comparison of Methods for Disinfecting Swimming Pools, Jour. Inf. Dis., 1917, No. 1, xx.
[5] Jour. Inf. Dis., 1917, xx.

help for titrating the chemical from time to time. Very often a quantity of disinfectant is added to the water, based on determinations with a fresh sample and far too little to produce good results. (2) Calcium hypochlorite is difficult to handle so as to produce no odor in the air of the pool room. Also a considerable amount of insoluble inert "sludge" is left behind which causes objection when thrown into the pool. To prevent clogging of the filters the hypochlorite is usually mixed in a pail and the supernatant fluid thrown into the water. Many other methods of adding the chemical to the water have been suggested, *e. g.*, the use of a feed pot on the filtration system, with a small bypass of water running through the hypochlorite solution and fed into the pool by the force of suction through a Venturi tube; the use of cheesecloth bags filled with the reagent to be dragged through the water, etc. While many of these methods of adding the chemical to the water are satisfactory it is seldom that no odors are produced in the air and no odors and taste in the water.

When we couple with the foregoing facts the smarting of the eyes of the bathers and the reduction in patronage of the pool which occasionally results we cannot conclude that hypochlorite sterilization of swimming pools is the ideal method to be recommended. In pools where careful supervision is maintained by a person with the proper technical training, calcium hypochlorite, and, for that matter, sodium hypochlorite and chlorin, can be used with excellent results. Usually, however, such supervision is not practised even in the very highest grade swimming pools, and so it has been found desirable to study automatic ("fool-proof") systems of pool purification.

Sodium Hypochlorite and Chlorin are identical with calcium hypochlorite in their action. Sodium hypochlorite, according to Manheimer, although more easily handled than calcium hypochlorite, is more expensive in application. Chlorin is inexpensive and much better to handle than either of the foregoing reagents, but it is difficult to get a reliable chlorin injector. All of these chemicals present the same objections in practical application.

Recently the applications of ultraviolet light and of ozone to pool purification have been made. Both of these processes are automatic in operation and eliminate the objections raised to the use of the halogens.

Ultraviolet Light.—Ultraviolet light has proved to be an efficient water sterilizer, providing sufficient time of exposure of the water to the light is maintained. According to the experiments of Thresh and Beale[1] many bacteria are killed after an exposure of from five to twenty seconds and resisting spores in from thirty to sixty seconds. An exposure of from ten to twenty seconds was found necessary to kill B. typhosus and V. cholera. They found a clear water with the absence of color, colloidal matter, and turbidity to be essential to the efficiency of the rays. Galeotti[2] found that much longer times of

[1] Lancet, December 24, 1910.
[2] Ann. de l'Inst. Pasteur, 1916, No. 2, vol. xxx.

exposure were necessary to destroy bacteria in water. Using suspensions of B. pestis and V. cholera in physiological salt solution and placing these suspensions on watch-glasses, so that the thickness of the suspension never exceeded 3 mm., Galeotti found it necessary to expose V. cholera for one minute and B. pestis from six to ten minutes.

In Petrograd an ozone plant and an ultraviolet ray plant were running in competition for the purification of the city water supply. The ozone plant has been a complete success and the ultraviolet ray an absolute failure, due merely to the turbidity of the water.[1] Cobb, Williams and Letton,[2] in a study for the United States Public Health Service of commercial ultraviolet light machines used for water sterilization on the Great Lake steamers, could not recommend them. These investigators concluded that it is of doubtful possibility to obtain a sufficient intensity of light to destroy bacteria if the generating lamps were operated at 110 volts or less. In addition to this they state: "It is essential when using ultraviolet rays to have the water clear, as any slight turbidity will considerably reduce their efficiency, due to the fact that a certain number of the bacteria present in the water will be protected by the shadow caused by minutely suspended matter. . . . There is a tendency, especially with a hard water, such as the lake waters, for a certain amount of the mineral salts to deposit on the quartz tubes, such deposits rendering the tube more or less opaque to ultraviolet rays, hence lowering the efficiency of the lamps." Manheimer[3] arrived at the conclusion, from a study on the application of the ultraviolet light to swimming-pool disinfection, that the time of exposure of the water to the light was insufficient to produce any marked bacterial reduction. The application of ultraviolet light in the purification of swimming pools to be effective would involve an increase in the number or size of the lamps with a corresponding increase in the cost of operation.

Ozone.—Ozone is produced commercially by passing atmospheric oxygen through a field permeated with a silent electrical brush discharge. The application of ozone in water purification has assumed great importance, as is proved by the numerous instances of successful application. According to Spaulding there are forty-nine large ozone plants abroad, having a daily water delivery capacity of over 84,000,000 gallons. The plant in Petrograd alone delivers 24,000,000 gallons a day and the plant at Paris over 12,000,000 gallons a day.

Opinion concerning the value of ozone in water purification is practically unanimous. Rosenau[4] states: "Ozone is one of the most satisfactory methods of purifying water from a sanitary standpoint. As a germicide it is the most effective of all methods used except boiling. A well ozonated water is practically sterile and the organic matter is partially oxidized. It is true that a few resisting spores are not killed,

[1] Ozone, D. van Nostrand Co., 1916, p. 154.
[2] United States Public Health Report, October 13, 1916, p. 2854.
[3] Jour. Inf. Dis., 1917, xx.
[4] Prevent. Med. and Hyg., p. 794.

but these are harmless when taken into the mouth." Powell[1] in a comparative study on water disinfectants, concludes: "It is readily seen that the use of ozone as a sterilization agent is considerably more efficient than many of the other sterilizing agents used for water purification, at the same time, owing to the fact that it can be used efficiently with water containing turbidity and colors comparatively high, while the other sterilizing agents cannot be guaranteed to maintain their efficiency under these conditions."

The only published reports of the application of ozone to pool purification of which we know are those of Manheimer.[2] His experiments have proved that under the conditions which obtain in swimming pools ozone can be depended upon for efficient work and inexpensive application. Ozone takes precedence over all other chemicals in pool purification, because of its automatic control, reliability of action and unobjectionable presence in the water. When copper sulphate, chlorin, sodium or calcium hypochlorites are used for swimming-pool disinfection only minimum quantities may be used, because an excess of any of these chemicals produces a water with objectionable tastes and odors. Furthermore, technical skill, rarely available in the average swimming pool, is necessary to determine the exact quantities of these chemicals for use. With ozone, an excess of the amount necessary for purification can and should be used at all times, especially since no objectionable odors or taste will be caused thereby. Indeed, it is just this feature which makes the automatic application of ozone a possibility.

The amount of ozone to be used for the purification of swimming-pool water is dependent on the time of exposure of the water to the ozone. If only a brief time of exposure is allowed a high concentration of ozone must be used. Obviously this increases the cost of application and causes a considerable waste of ozone. It should be remembered that ozone is not produced pure but in combination with air, in various concentrations. Since neither air nor ozone is soluble in water to any appreciable extent, thorough mechanical mixing of the ozonized air and water must be effected to ensure disinfection. Many methods of accomplishing this mixing have been devised, but it is safe to say that no method has been suitable to replace that of the liberation of the ozonized air at the bottom of tall water towers. Where towers of sufficient height are used a concentration of ozone in air sufficient to supply one part ozone to 1,000,000 parts of water is ample for pool water as well as for drinking-water purification. Careful experiments have been conducted for the purpose of ascertaining the best proportion of ozonized air to water, and the conclusion has been reached that at least twice as much ozonized air as water should be used. The air breaks up into fine bubbles while passing upward through the tower, the water forming thin films on the surface of the bubbles.

[1] Jour. Ing. and Eng. Chem., July, 1916, No. 7, vol. viii.

[2] U. S. Public Health Rep., March 1, 1918; Jour. Am. Med. Ass., June 29, 1918; Boston Med. and Surg. Jour., vol. clxxix, No. 21, p. 642.

The close proximity of all substances in the water to the ozonized air accounts for the efficient oxidation which results.

Bacteriological Standards.—No bacteriological standard for swimming-pool water has been definitely proposed; nor is it likely that a figure for gross bacterial count will be generally accepted in view of the widely varying results reported by different investigators.

For the water supplied to a pool, or used at a bathing beach, it has been generally felt that no water should be offered which does not conform with the bacterial standards for drinking water, at least after purification. That this view is not universally held, however, is evident from the regulations in the State of Illinois, where the widely variable conditions throughout the State are considered before disapproving a bathing place. "A count of five hundred bacteria per cubic centimeter and colon bacilli not to present an excess of 25 per cent. in 1 c.c. portions" are the figures which are used as a basis of decision for the upper limit of pollution.

The only locality where an upper limit is placed on bacterial contamination in a swimming pool is in New York City. Here the swimming pools are required to operate so that the number of colon bacilli per cubic centimeter in the water will not exceed ten. This seems to be a fair upper limit, to which swimming-pool water should be made to conform. The difficulty of deciding upon a definite bacterial count has given rise to the desire to standardize swimming-pool equipments and layouts, and modes of operation and administration. Indeed if a suitable equipment and plan of administration exist at a pool, it is safe to say that the pool will be maintained in a sanitary condition.

MIKVEHS.

Mikvehs, strictly defined, are Jewish ritual baths. The term Mikveh, however, as commonly used by the Jewish people, includes baths of similar type, though not always of a purely ritual nature. Accordingly, Mikvehs can be best classified as (1) sanctioned Mikvehs (true Mikvehs, sanctioned by Rabbis) or Jewish ritual baths for women, and (2) unsanctioned Mikvehs, divisible into (*a*) common Mikvehs or plunge baths operated at elevated temperatures and used as cleansing baths and (*b*) cold plunges operated in conjunction with Turkish sweat rooms.

The first study of the sanitation of Mikvehs was that of Porter,[1] who reported on their polluted condition. Subsequent studies by Manheimer[2] resulted in definite action by the Department of Health for the purpose of improving their condition.

1. *The Sanctioned Mikveh* is the only true Mikveh, its use being a necessary part of Jewish ritual. Stringent Talmudic laws govern the use of the ritual plunge, which if carried out in letter and spirit would make sanitary inspection and control of these baths entirely unneces-

[1] The Survey, July 27, 1912.
[2] The Survey: April 18, 1914, August 28, 1915; Jour. Inf. Dis., vol. xv. No. 1, p. 159.

sary. The ritual dip is required of women at all periods within seven days after menstruation, prior to certain holidays, before marriage, etc. Men are not required by religious law to take the ritual dip, although certain sects of Jewish people have acquired the custom of using the Mikveh as a semireligious practice.

The sanctioned Mikveh, a tank usually of about 200 cubic feet capacity, is used by a relatively small number of people. A preliminary cleansing bath is required before the ritual dip is permitted, and consequently the water in this type of bath is usually in good condition. A careful regard for the management of the water, including its daily renewal, or more frequent renewal depending on the number of people using it, periodical[1] disinfection, together with the providing of clean towels, liquid soap, individual drinking cups, etc., should prove adequate to effect suitable sanitary conditions in these premises.

(*a*) *The Common Mikveh* consists of a plunge bath of between 200 and 400 cubic feet capacity, the water in which is maintained at an elevated temperature. This bath is frequented for the same reasons as Turkish baths, the Mikveh plunge being used as a common cleansing bath by a large number of people. The very nature of this type of bath precludes the possibility of its sanitary maintenance and the conclusion was reached that this type of pool should be abolished.

(*b*) *The Cold Mikveh*, operated in conjunction with Turkish sweat rooms, falls into the category of swimming pools and should be controlled in like manner. Unfortunately, these pools are operated in conjunction with establishments where the general sanitary conditions are bad. Insufficient ventilation, soiled linen on beds and couches, common combs, brushes, drinking cups, etc., and the existence of dangerous conditions of fire hazard are the chief matters reported.

LAWS.

The States of Idaho, Louisiana and New York have passed laws governing the conduct of swimming pools. The States of California and Utah have recently introduced laws which at the time of this writing are under consideration for passage. The cities of San Francisco, Saginaw, Albany, New York, Salt Lake City, and Seattle have also passed regulations on swimming pools. Portland, Oregon, has recently introduced and passed ordinances relating to this subject. While many States and municipalities have no specific laws or ordinances relating to swimming pools, many have passed regulations to which the pools must conform and which are tantamount to laws. Many localities are considering the formulation of laws and ordinances on swimming pools and a brief description of the field to be covered by them may be useful.

Standards for Swimming-pool Legislation.[2]—No attempt is made to set forth regulations; merely tentative standards are proposed, up to

[1] For a full discussion of this subject see Manheimer: "Sanitary Condition of Mikvehs and Turkish Baths," Medical Record, February 2, 1918.

[2] Manheimer: Medical Record, March 9, 1918.

which the laws should measure. The language of the ordinances will vary in the different localities and modification of details may be called for as a result of different local conditions.

The standards suggested can be conveniently classified as: (1) those concerning the management of the water, (2) those relating to construction, safety devices and fire hazard and (3) sanitary control of premises and bathers.

I. *Standards Concerning the Management of the Water.*—1. The bacterial contents of the water supplied to a swimming pool must conform with that of drinking water, or if polluted, must be disinfected before use.

2. The water in the swimming pool during use must be continuously diluted by adding fresh water, or, better, by reusing the water from the swimming pool after filtration and purification.

3. The water must be maintained clear at all times to an extent at least sufficient to see a submerged person in any part of the pool.

4. The water must be either periodically and regularly or continuously disinfected, unless emptied daily. The bacterial count must not exceed 10 colon bacilli per cubic centimeter.

5. The method of disinfection must be satisfactory to the Department of Health.

6. The water from the pool must, when discharged cause no contamination of any stream used for drinking purposes and should, if possible, be disposed of as sewage water.

II. *Standards Concerning the Construction of Pools, etc.*—1. The lining of the pool must be white (or nearly so), smooth (readily cleansable) and impervious to water. The corners of the pool should be rounded.

2. There must be no obstructions in the water. Stairs and stair supports must be of metal or stone.

3. Water from the floor surrounding the pool must not drain back into the pool.

4. The floor must be constructed of material impervious to water, must be adequately drained and composed of material designed to prevent slipping and, if possible, a poor conductor of heat.

5. There must be a scum gutter on at least two opposite sides of the pool, and preferably completely surrounding the pool, for the purpose of draining off the surface dirt and of affording a place for bathers to spit. The scum-gutter must drain into the sewer or cesspool and not back into the recirculation system.

6. Construction should be made with due regard to the elimination of fire hazards, taking into account the providing of sufficient exits to accommodate the largest crowd that would be likely to attend exhibitions, etc.

7. The pool should be shallow at one end and deep enough at the other to permit diving with safety, unless constructed as a wading pool for children.

8. Dressing-room compartments in indoor pools must be constructed vermin-proof.

9. Bathing establishments should be under permit of the Department of Health to include construction and operation.

10. Adequate shower-bath and toilet facilities must be provided; also hot water for showers in indoor pools. Toilets must be screened against flies, unless water-flushed and covered by toilet lids.

11. Sanitary drinking fountains with pure water must be supplied.

III. *Sanitary Control of Premises and Bathers, etc.*—1. Adequate light and ventilation must be provided.

2. A temperature of the air during the winter in indoor pools of between 70° and 80° F., must be maintained.[1]

3. No common towels, combs, brushes or drinking cups may be provided.

4. All towels, suits, etc., provided by the establishment for public use must be sterilized after each separate use.

5. Anti-spit signs must be conspicuously posted. Signs in large letters must be posted in dressing compartments directing all bathers, men and women, to take a preliminary cleansing shower in the nude with warm water and soap and to empty the bladder before going into the pool. Bathers must rinse off all soap before entering the pool room.

6. No diseased or intoxicated person should be permitted to use a swimming pool.

7. Only those persons dressed or undressed for bathing may enter the pool room.

8. Men and boys must bathe in the nude or be provided with sterilized suits. Suits for men and women must be of fast color and of a lintless material.

9. A lifeguard must be present at all times. He must be acquainted with the technic of resuscitation of the apparently drowned and have equipment at hand for rescuing and resuscitating. He, or some attendent must supervise the incoming bathers to enforce the regulation concerning the preliminary bath and to exclude undesirable and diseased persons.

10. The room must be locked during the emptying and refilling of the pool (or other steps be taken), so that bathers will not dive into an empty pool.

11. The pool when emptied must be well scrubbed.

12. No smoking should be allowed in indoor pools.

13. Cuspidors must be provided in the dressing rooms and pool rooms.

14. If tub baths are supplied they must be disinfected after each separate use.

[1] It is usually deemed necessary to maintain a higher temperature in bath buildings, than in living rooms, school rooms, etc.

CHAPTER XIX.

PERSONAL HYGIENE.

By EUGENE LYMAN FISK, M.D.

In the early stages of public health work, the health officer was confronted with formidable and often insoluble problems relating to the prevention or eradication of communicable disease. With the growth of knowledge as to the causation of these maladies, the task of the health officer in the protection of the community has been much simplified.

While the prevention and stamping out of communicable disease still makes heavy demands upon the resourcefulness and scientific equipment of the health officer, his problems in this relation are so simplified that a by-product of tremendous value would be wasted if the opportunity more completely to safeguard the public health by education in personal hygiene were neglected. In fact, so tremendous is the opportunity in this direction offered the public health officer that instead of his work dwindling in importance as methods of sanitary control and the prevention of epidemic disease become standardized and easily applied, it may be said to have greatly broadened and also risen to a greater dignity and importance in its possible influence on human life and public welfare. While here and there some reactionary may object to such activities on the part of the health officer, the enlightened tax-paying citizen will be very grateful to such an official for making readily available, the knowledge of how to live so that illness, physical inefficiency and premature breakdown may be avoided. It is surely quite as much a proper function of public health administration to acquaint the people with the dangers of overfeeding as it is to protect the community from adulterated and impure food. Without in the least belittling the good results of the administration of pure food laws, it is conservative to state that more injury has been sustained by the public through improper feeding than through adulterated food.

The family physician who warns his patient does not always receive attention, but the utterance of an official health department will in time command public attention and gradually mold public opinion in a way that cannot be done by the scattered, unstandardized and varying efforts of individual physicians. The health officer who is alive to these opportunities and desirous of improving them will do well carefully to survey the field of knowledge on these subjects and plan his educational campaign along systematic lines, following no

fads and marshalling adequate scientific support to the principles inculcated. At the outset it is important to obtain a correct viewpoint of the possibilities of this work and of the ultimate goal that should be its object.

WHAT IS PERSONAL HYGIENE?

Personal or individual hygiene implies "high ideals of health, strength, endurance, symmetry and beauty; it enormously increases our capacity to work, to be happy, and to be useful; it develops, not only the body, but the mind and the heart; it ennobles the man as a whole."

In order to be free to carry forward this work with proper flexibility and openness of mind, it is necessary to rid ourselves of much accumulated tradition and of the paralyzing influence of the classification and terminology of disease. Current classifications of disease still reflect the influence of the outworn theory that diseases are entities arising without specific cause, afflictions in the nature of "acts of God." There is needed a thorough revision of the classification of disease with more attention to etiology. As one general disease after another is found to be actually due to infection, we are led closely to analyze all forms of physical deterioration or impairment, and as we do this we are led to see the folly of regarding any form of disease as self-initiated, as having any possibilities of progression without the continuous operation of some specific cause or group of causes. As our vision clears on these points, we are led to seek and analyze these causes with greater precision, and we have forced upon us the conviction that the term disease is a misleading one, that in so-called disease, we are dealing with an organism manifesting various forms of impairment, tissue change or disturbance of function. Whether these changes rise to the dignity of a disease is partly a matter of degree and partly a matter of opinion.

When a man's kidneys and circulation prove obviously insufficient we label him as having "Bright's disease." Slowly developing changes may have been taking place in his tissues for many years, not *because he had Bright's disease*, but because some one or more of a group of possible causes had been at work on his body. It will be helpful in clarifying this subject to group the various factors or types of influences that are responsible for physical deterioration, substandard health conditions, chronic disease, premature old age and death.

1. Heredity.
2. Physical strain. Muscular excess and organic strain. Mental and emotional strain or imbalance.
3. Physical apathy, muscular disuse, faulty physical posture, skin disuse (improper clothing). Mental and emotional apathy, and disuse, faulty mental posture.
4. Food excess, quantitative, and qualitative. Food deficiency, quantitative and qualitative (food accessories). Hormone deficiency.

5. Poisoning:
   - Drugs.
   - Metabolic poisons.
   - True auto-intoxication.
   - Hormone excess.
6. Infections, bacterial and parasitic.
   - Focal: Teeth, tonsils, sinuses, urethra, seminal vesicles, etc.
   - General: Syphilis, typhoid, tuberculosis and all communicable diseases.
7. Trauma, mental and physical.

In the above probably infection plays the largest part. Mayo has truly said: "Life is one long struggle with microörganisms."

A careful consideration of these causative factors, clears the way for a formulation of the fundamental principles of personal hygiene which can be brought into play for the most complete protection of the individual as well as for the up-building of his health.

The first great commandment in personal hygiene is to have your body periodically examined so that the rules of hygiene may be applied with precision. Exercise, diet, all may be without avail if you are working against a septic tonsil or a tooth abscess. What has built up your neighbor may break down your own health. After your physical condition is ascertained, the following rules of hygiene as prescribed in the Institute's book *How to Live*, may be taken as a suggestive guide.

(*a*) *Air.*

1. Ventilate every room you occupy.
2. Wear light, loose and porous clothes.
3. Seek out-door occupations and recreations.
4. Sleep out if you can.
5. Breathe deeply.

(*b*) *Food.*

6. Avoid overeating and overweight.
7. Eat sparingly of meats and eggs.
8. Eat some hard, some bulky, some raw foods.
9. Eat slowly.

(*c*) *Poisons.*

10. Evacuate thoroughly, regularly and frequently.
11. Stand, sit and walk erect.
12. Do not allow poisons and infections to enter the body.
13. Keep the teeth, gums and tongue clean.
14. Use sufficient water internally and externally.

(*d*) *Activity.*

15. Work, play, rest and sleep in moderation.
16. Keep serene.

A great deal of harm has been done by well-meaning people seeking to educate the public in right living. It happens all too frequently that an enthusiastic health reformer will take up some particular phase of personal hygiene and not only overemphasize its value but in

endeavoring to group all conditions of ill-health under its possible curative or preventive influence, discredit the whole movement for rational health reform. Well-balanced personal hygiene involves a practice of each phase of right living. There is no magic system of exercise, of diet, of mental hygiene, of psychotherapeutics, the practice of which alone will lead to perfect health.

While it is true that the health officer must rely chiefly upon educational methods in guiding the hygiene of the people, he can, nevertheless, emphasize as one of the fundamental requirements in intelligently applying the laws of right living, that people from early childhood on should be subjected to periodic physical examination so that individual needs and idiosyncrasies can be given due consideration in applying the various rules of hygienic living. The calm and supine acceptance of the seven ages of man as an inevitable limitation upon humanity is, of course, paralleled by many other ages-old abuses and traditions which have burdened the human race. In the past decade, however, the idea of periodically examining the human machine has gained great support. It is now very widely talked about although its benefits are only extended to a comparatively small number of people in proportion to the total population.

Pioneer Work.—The first great experiment along these lines on any large scale was tried in an insurance company about nine years ago with results so startling that the proposal to extend such benefits to policy-holders generally was readily entertained by a group of scientific men and publicists who established the Life Extension Institute in 1914. A number of companies now extend this privilege of periodical examination and hygienic guidance by the Institute to their policy-holders. The practice of physical examination of employees before employment and thereafter has expanded quite widely and is now a matter of vital interest pertaining to the welfare and efficiency of industrial employees.

EXAMINATION OF INDUSTRIAL AND COMMERCIAL EMPLOYEES.

		Industrial men, average age of 34 years. Per cent.	Commercial men, average age of 26 years. Per cent.
Class 1.	No physical impairment reported and no modification of living habits required	0	0
Class 2.	Slight physical impairment or defects requiring observation or hygienic guidance	10	10
Class 3.	Moderate physical impairment or defect requiring some form of hygienic guidance or minor medical, dental or surgical treatment	41	52
Class 4.	Moderate physical impairment or defect, medical supervision or treatment advised, in addition to hygienic guidance	35	27
Class 5.	Advanced physical impairment or defect requiring systematic medical supervision or treatment	9	9
Class 6.	Serious physical impairment or defect urgently demanding immediate attention	5	2

The Life Extension Institute has examined about 150,000 people, more than half of whom have been found showing impairments or functional derangements of a character that would warrant medical or surgical attention.

The analysis on page 479 showing the results of the Life Extension Institute's examinations among some thousands of industrial and commercial employees actively at work, enables us to take a "birds' eye view," as it were, of the physical condition of civilized man.

In the examination by especially trained examiners of 5000 individuals in various walks of life, people who in the mass regarded themselves as in fairly good condition, but were nevertheless moved to seek a service that would improve their state of health and lengthen their lives, the following percentages were found:

Ages.	*Class 1. Per cent.	Class 2. Per cent.	Class 3. Per cent.	Class 4. Per cent.	Class 5. Per cent.	Class 6. Per cent.	Per cent.
Under 25 . .	0	.003	27	32	37	4	100
25 to 44 . .	0	.001	18	28	46	8	100
45 to 64 . .	0	0	11	22	55	12	100
65 and over .	0	0	6	15	60	19	100

These figures when first published were looked upon with some skepticism by many who were attuned to the results obtained in ordinary physical examinations which were not standardized and did not aim rigorously to cover each region of the body even though no condition of illness was apparent. Sentiment has very materially changed in this regard, however, since the publication of the results of the draft examinations. Although the most favorable age group in the population, that between twenty-one and thirty-one was taken, 34 per

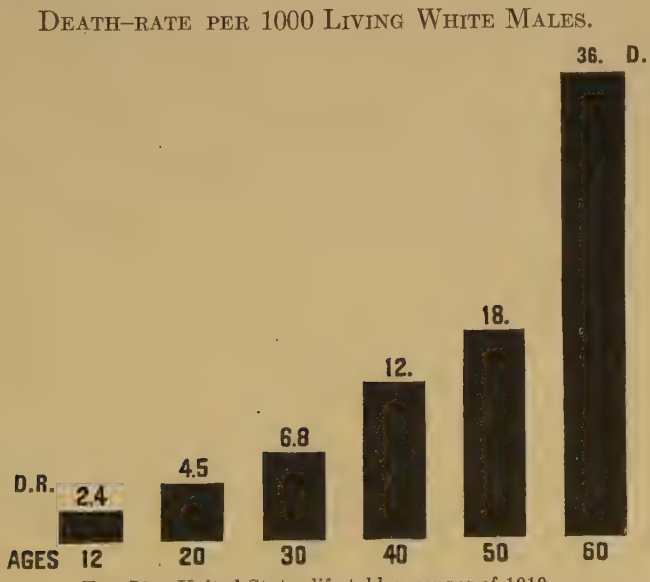

FIG. 76.—United States life tables, census of 1910.

* These classifications identical with the preceding.

cent. were declined in the first draft as physically unfit. (This includes those rejected at the camps.) An analysis of seven boards made by the writer showed the following causes of rejection:

ANALYSIS OF SEVEN LOCAL BOARDS IN DETROIT, BROOKLYN AND NEW YORK.

	Number.	Percentage of those examined.
Number of men called	8875	....
Number of men examined	7611	....
Number of men discharged for physical reasons	2232	29.
Prominent causes of rejection:		
Defective eyes	462	6.
Defective teeth	366	4.8
Underweight	350	4.6
Hernia	223	2.9
Heart defects	184	2.4
Defective feet	180	2.3
Injured or amputated limbs	169	2.2
Defective ears	88	1.2
Tuberculosis of lungs	77	1.
Tuberculosis of joints	2	....
Undersize	53	0.7
Genito-urinary bladder, etc.	37	0.5
Varicose veins	35	0.4
Overweight	32	0.4
Syphilis	32	0.4
Varicocele	28	0.3
Deformity of trunk	38	0.5
Asthma, bronchitis, etc.	21	0.3
Mental and insane	14	0.2
Debility and poor physique	16	0.2
Miscellaneous injuries	15	0.2
Hemorrhoids	13	0.2
Kidney disease	10	0.1
Rheumatism	8	0.1
Miscellaneous defects	7	0.1
Epilepsy	7	0.1
Fistula	5	0.06
Alcoholism	4	0.05
Hydrocele	4	0.05
Diabetes	4	0.05
Goiter	6	0.08
Deaf mutes	6	0.08
Skin	4	0.05
Liver and gall-bladder	3	0.04
Drug habit	3	0.04
Injury to nervous system	3	0.04
Kidney removed	2	0.02
Neurasthenia	1	0.01

When it is considered that many men were sent up to the cantonments who were really physically unfit and had minor defects which could be corrected, and that the vast majority that were accepted required a great deal of physical training and hardening before they were considered fit to be sent abroad (47 per cent. of those examined showed some form of defect), it can be readily seen that the findings of the Life Extension Institute were consistent with those of the draft findings, making due allowance for the fact that the draft examinations were necessarily hurried and incomplete, inasmuch as a single cause of rejection was sufficient to act upon without further

analysis. Later drafts showed similar conditions, although many with remediable defects were accepted and sent to the cantonments in view of the special provision that had been made for such work following the first draft.

An analysis of the causes of rejection in the U. S. Marine Corps reveals similar conditions of human impairment.

ANALYSIS OF PHYSICAL CAUSES FOR REJECTION FOR MILITARY SERVICE, U. S. NAVY AND MARINE CORPS, 1916 (REPORT OF SURGEON-GENERAL).

	Number.	Percentage of men examined.
Number of applicants	113,932	
Number of men examined	82,592	
Number of men rejected for all causes	51,167	62.00
Causes of rejection:		
Eye defects	9,452	11.40
Underweight	5,397	6.50
Flat-foot	5,028	6.08
Defective teeth	4,878	5 90
Deformities	3,533	4.30
Varicocele or varicose veins	3,105	3.80
Heart affections	2,302	2.80
Height, under	2,124	2.60
Poor physique	1,633	2.00
Ear defects	1,376	1.70
Genito-urinary, venereal	1,347	1.60
Hernia or tendency to	1,312	1.60
Skin disease	1,094	1.30
Height and weight, under	921	1.10
Tuberculosis or suspects	909	1.10
Pyorrhea	896	1.08
Tonsillar conditions	588	0.72
Genito-urinary, non-venereal	548	0.66
Nasal abnormalities	476	0.57
Febrile conditions	381	0.46
Mental disorders	302	0.36
Goiter or tendency to	294	0.35
Defective speech	132	0.15
Miscellaneous causes	2,820	3.41

These physical insufficiencies of our adult male population clearly show the tremendous opportunity for preventive work, for repair work and for constructive work. They also show that not only is there an opportunity to do this work but that it must be done if we are successfully to carry forward our civilization.

An interesting experiment along these lines has been carried on in North Carolina by the State Health Commissioner, Dr. Rankin. A physician trained in the head office of the Life Extension Institute to work along standardized lines has been making physical examination of adults in certain counties under the joint auspices of the State Health Department and the county, its purpose being to discover evidence of chronic disease and physical deterioration. The results of these examinations are consistent with the findings of the Life Extension Institute and have served as a valuable stimulus to personal hygiene and to careful diagnostic work in the communities affected. This work is to be carried on through the State.

Periodic health examinations are now the rule in the New York City Health Department and have resulted in distinctly lowering the sickness rate.

More and more there is a tendency on the part of city and State health departments to enter the field of work dealing with the influences that bring about chronic diseases. The New York State Health Department has entered on an extensive campaign throughout the State by means of exhibits and bulletins dealing with the diseases of adult life and their prevention by proper living habits and especially by periodical health examinations.

The question as to whether this physical deterioration is on the increase or decrease has been much debated. It is unfortunate that our census statistics until very recent years were so inadequate, that it is difficult to carry backward a statistically accurate comparison, yet when due allowance is made for all possible fallacies, for the incompleteness of the records, as well as for changes in classification and advance in diagnosis, etc., there seems evident a tendency to an increase in the chronic organic diseases which is also reflected in an increase in the mortality in the later decades of life.

DEATH-RATE PER 10,000 LIVING—HEART, BLOODVESSELS, KIDNEYS.

England and Wales.				U. S. Registration area.			
1890.	1900.	1910.	1914.	1890.	1900.	1910.	1915.
30	29	26	30	27	33	38	39

The above table may be accepted as fairly revealing the general trend of mortality in this class of disease. Critics of this viewpoint have claimed that this apparent increase is due to changes in classification, to improvement in diagnosis, to influx of immigration. Making due allowance for all such possible influences the writer has been unable materially to affect or alter the evidence as to the increased mortality from these maladies as shown in the above table. The trend of mortality in Sweden, Denmark and Prussia has been in the direction of improvement at every age period of life. There was a similar trend in England and Wales until the past few years, when the war has rendered comparisons unsafe. An upward trend in these maladies is shown in England and Wales and likewise an increase in mortality in later age periods during the past few years. The fact should be borne in mind that in this country a totally different line of research, that seeking to ascertain the mortality by age periods, gives consistent results, pointing toward at least a failure to effect any saving of life in the later age periods. The downward sweep of the communicable diseases cannot be disputed. To this, and to the saving in child life must be ascribed the consistent and steady fall in the general death-rate. Putting these debatable questions aside, however, no one can question the fact that there is widespread physical impairment and physical insufficiency and that no further incentive is needed to impel us to the most vigorous effort in the direction of improving the physical resistance of the race.

PRINCIPLES OF CORRECT DIET.

Public instruction on diet should relate not merely to the common errors, such as overfeeding, underfeeding, excess of protein, vitamine deficiency and the like, but should aim to convey knowledge of the simple fundamental principles of correct diet and of the nutritional needs of the body. The individual should be taught to think for himself and intelligently govern his own diet without the need of didactic warnings and admonitions.

While there are many unsettled problems in dietetics the main facts required for the guidance of individuals under ordinary living conditions are well established and the principles of their application are so simple that to be ignorant on this matter is inexcusable. We may confidently expect that the average schoolchild of the next generation will know more about diet than the average physician of today.

The war has greatly extended the knowledge even of leading physiologists with regard to the principles of nutrition. There is no longer any dispute as to the sufficiency of the Chittenden low protein standard. War experience has settled this debate which was rapidly becoming academic. Benedict's recent experiment at the Nutrition Laboratory of the Carnegie Institution, with a diet squad placed on a low calory war ration of 1400 calories per diem, has likewise shown that the basal metabolism formerly fixed by him was not an irreducible minimum and could be lowered about 30 per cent. when the body had become adjusted to a reduced ration and a lower heat production.

This experiment has been covered in a report entitled "The Effects of a Prolonged Reduced Diet on Twenty-five College Men," by Francis G. Benedict, Walter R. Miles, Paul Roth and H. Monmouth Smith.

In no field of personal hygiene is it more important carefully to search the recent literature, and especially that of physiological research, in order to base instruction upon demonstrated truths or at least upon the latest consensus of scientific judgment. The checking up of theories, and especially those in text-books which are often out of date before they are published is extremely important. Much popular educational matter on health is inaccurate and unbalanced for lack of this precaution.

While public instruction cannot be loaded down with qualifications, possible fallacies, alternative theories, etc., but must be as simple and direct as possible and perhaps often a little more dogmatic in its tone than would be warranted in purely scientific discussion, unsettled theories should be stated as such and the trend of the best opinion set forth. There is nothing so discouraging to the public mind as to have a heralded scientific theory completely reversed. There is a happy medium in these matters which the health educator should endeavor to attain. . . .

The health officer will need to safeguard the public in the matter of diet chiefly along the following lines:

Undernutrition or badly balanced nutrition in childhood.

Overnutrition or badly balanced nutrition in adult life.

Wasteful expenditure for food.

Faulty eating habits. Neglect of the psychic value of eating.

Faulty and wasteful preparation of food.

Any attempt to educate the public in a mathematical prescription of diet as to calories, proteins, etc., is, in the author's opinion, unwise. The constitution of various food substances as to calories, minerals, etc., it is well to know, but it is far more important for an individual to weigh his body than to weigh his food or count his calories. Knowing the low and high calory foods, his consumption of these can be governed according to his weight and not according to his theoretical requirements. His actual individual requirements can really only be determined in advance in a respiration calorimeter.

As a suggestive model for simple popular instruction on dietetic principles, the following, taken from the book *How to Live* of the Life Extension Institute may prove of value.

The Fundamental Principles of Correct Eating.—The human body is very much like an engine. It needs fuel to keep it running. As it has to be built so must it be repaired from time to time, also it must be regulated, hence, we need (*a*) fuel food, (*b*) building or repair food, (*c*) regulating food.

Fuel Foods.—As in the case of an engine, the main requirement is for fuel. Unlike an engine, however, if the human body does not secure sufficient fuel it will literally burn to death, the tissues being drawn upon to supply the fuel. On the other hand, the human engine may easily become overstoked by an excess of fuel. The following list shows the main fuel foods, the great foundation foods of the diet, that supply energy for muscular work. Mental work requires so little extra fuel that it is not necessary to consider specially. There are three groups of fuel foods. Here they are in the order of their cost per calory, those giving most energy for the money heading the list:

1. *Starchy foods:* Cornmeal, hominy, broken rice, oatmeal, flour, rice, macaroni, sphaghetti, cornstarch, dried lima beans, split peas (yellow), dried navy beans, bread, potatoes, bananas.

2. *Sugars:* Sugar, corn syrup, dates, candy, molasses, most fruits.

3. *Fats:* Oleomargarine, nutmargarine, drippings, lard, salt pork, peanut butter, milk, bacon, butter and cream.

About 85 per cent. of the fuel for the body should come from these groups, using starchy foods in the largest amount, fats next and sugars least.

Building and Repair Foods.—These are divided into proteins and mineral salts.

1. *Proteins or "Body Bricks."*—These food elements are found in greatest abundance in lean meat of all sorts (including fish, shell food and fowl), milk, cheese, eggs, peas and beans, lentils and nuts. There

is also a fair amount of protein in cereals and bread (about 10 per cent.), which are both building and fuel foods. Most foods contain some protein. Those above mentioned are richest in protein and hence are termed "building" or "repair foods."

The following is a list of the building and repair foods in the order of their cost, those giving most building and repair material for the money heading the list:

Beans (dried white), dried peas, oatmeal, cornmeal, beans (dried lima), bread, bread (whole wheat), bread (Graham), salt cod, milk (skimmed), Cheese (American), peanuts, macaroni, mutton (leg), beef (lean rump), milk, beef (lean round), lamb (leg), eggs (2d grade), halibut, porterhouse steak, eggs (1st grade), almonds (shelled).

2. *Mineral Salts.*—These are found in milk, green vegetables, fruit, cereals made from the whole grains and egg yolks.

Regulating Foods.—1. *Mineral Salts.*—These minerals which have been mentioned as repair foods, are also regulating foods, and help to keep the body machinery running properly.

2. *Water.*—Water is an important regulating food. Many people drink too little. Six glasses of water a day is the average requirement—one between meals and one at meals.

3. *Ballast or Bulk.*—This is furnished by cereals and vegetable fiber, which is found in whole wheat or Graham flour, in bran, leaves and skins of plants and skins and pulp of fruits. Examples are: Vegetables—peas, beans, lettuce, watercress, endive, parsnips, carrots, turnips, turnip tops, celery, oyster plant, cabbage, Brussels sprouts, tomatoes, salsify, Spanish onions, spinach, beet tops, kale, dandelions. Fruit—apples (baked or raw), pears, currants, raspberries, cranberries, prunes, dates, figs, oranges.

4. *Hard Foods.* Vigorous use of teeth and jaws is insured by hard foods, such as crusts, hard crackers, toast, Zwieback, fibrous vegetables and fruits, celery and nuts, which are necessary to keep the teeth and gums in a healthy condition.

5. *Accessories or Vitamines.*—These are minute substances present in varying amounts in a large variety of foods and apparently necessary to keep the body in health. That is, the absence of these substances seems to lead to poisoning of the body, which results in such disturbances as scurvy, beri-beri and other so-called "deficiency" diseases. Milk, eggs, whole cereals, potatoes, citrus fruits, tomatoes (fresh and canned) and green vegetables, especially spinach and leafy vegetables and fresh meat are thought to contain them. It seems necessary to include the leaves of plants (green vegetables) when the seeds (cereals, grain, flour, etc.) are used. Fruit and vegetable acids are regulating. They maintain the reserve alkalinities of the blood and prevent constipation. Milk is also necessary to supplement a cereal diet as even liberal quantities of green vegetables cannot wholly take the place of milk.

SUMMARY. While we know that a man of average weight, of moderate activity, requires from 2500 to 3000 calories or heat units,

of food daily, it is not necessary to measure the calories, but to watch the scales. If your weight is in equilibrium (see weight tables and weight instructions) you do not have to worry about your calories. It is not at all likely that you need worry about your protein as that is present in sufficient quantity in all but very narrow diets. In fact, you are more likely to get too much protein than too little. If your diet is well diversified and includes a liberal admixture of the regulating foods your diet is safe. That is, weight in equilibrium, protein taking care of itself, as a rule, excess avoided by eating meat or high protein food not more than once daily, and regulating elements supplied by milk, vegetables and fruit, and some raw food each day, the needs of the average individual are covered.

The needs of the individual are not supplied by a meat and potato diet.

Food should be thoroughly chewed or insalivated in order to insure good digestion and prevent overeating, especially of protein food. This can easily be attained, not by directing attention to chewing, but by tasting the food thoroughly until it slides naturally down the gullet into the stomach. If attention is given to tasting the food during the first few chews the habit will easily be formed.

While it is not necessary to weigh your food or measure the calories or heat units that it furnishes, it is well to know the varying requirements of different types of individuals as shown below:

Grandparent (seventy to eighty years), 1500 to 1800.
Father, 3000.
Mother, 2500.
Boy or girl of thirteen years, 3000.
Boy or girl of nine to eleven years, 2500.
Boy or girl of seven years, 2100.
Boy or girl of three to four years, 1100 to 1400.

Hard manual labor will increase requirement of father to 4000 or more calories.

The calory is a unit of heat measurement and represents the amount of heat required to raise one kilogram of water 1° C. or 1 pound of water 4° F.

MENACE OF OVERWEIGHT.

For many years the life insurance companies have been accumulating evidence of the unfavorable influence of overweight. There has lately been available from the medico-actuarial investigation of the experience of forty-three American life insurance companies collected evidence showing the influence of build on longevity. This experience brings out the simple fact that the ideal weight after full maturity (about thirty-five years of age) is somewhat below the average weight. Light weight in early life shows a slightly unfavorable mortality, due to the high incidence of tuberculosis in these types. After thirty-five years of age light weight is an advantage rather than a detriment.

Overweight, however, shows a progressive increase in mortality with the increase of weight. The tables on pages 484 and 485 set this forth very clearly. The tendency to increase in weight as one grows older is pathological and not physiological, and should be combated.

Benedict's laboratory experiment, referred to in a previous section, supports this statistical evidence, and again we have the evidence from many sources that restriction in diet when not carried to too great an extreme has resulted in improved health rather than debility.

The public should be warned against drastic, strenuous, reduction methods. Barring overweight due to dropsy or to distinctly pathological conditions, which require careful medical government, overweight is very easily corrected by dietetic measures alone. A great deal of harm has been done by physical culture enthusiasts who endeavor to take off weight by strenuous exercise. This is particularly dangerous to the middle-aged.

Before a middle-aged individual should be subjected to anything more than very moderate exercise the weight should be reduced very materially, so that the burden may be taken from the circulation. It is probable that the heart muscle of the average middle-aged overweight is below par. To ask such a heart to go against not only overweight but unusual exercise is palpably unreasonable and unscientific.

A man could sit at his desk and automatically reduce his weight without any exercise. He could even lie in bed and reduce his weight by dietetic measures and without going hungry. It is simply necessary to concentrate on the bulky foods of low fuel value. It is not necessary that he cut out carbohydrates and fats, but cut them down. A great deal of harm has been done by popular instruction based upon a glimmering of this truth but carried to an absurd extreme. It is not necessary to starve an individual or subject him to any real privation in order to reduce the weight. Sensations of hunger can be appeased by bulky foods that have almost no fuel value so far as calories are concerned. A person can eat four or five times a day and lose weight. The no-luncheon practice is entirely unnecessary and may have the harmful effect of depriving an individual of the psychic value of a break in the day's work. The following dietetic principles afford a safe guide for the average overweight individual and for the child:

Suggestions for Regulation of Diets.—Where there is a tendency to overweight a very careful modification of the average, normal diet is necessary, concentrating strongly on the bulky foods, and eating but lightly of the fuel foods. It is not, of course, wise to cut out entirely the fuel foods, such as fats, starches and sugars, but cut them down sufficiently to bring the weight gradually to the normal point.

In cases of positive disease, where overweight is due to dropsy, disturbances of thyroid gland, etc., reduction should only be attempted under strict medical supervision.

INFLUENCE OF WEIGHT ON VITALITY. PERCENTAGE OF NORMAL INSURANCE MORTALITY IN VARIOUS WEIGHT GROUPS BASED UPON THE REPORT OF THE MEDICO-ACTUARIAL INVESTIGATION 1912 COVERING AN ANALYSIS OF 744,672 MEN.

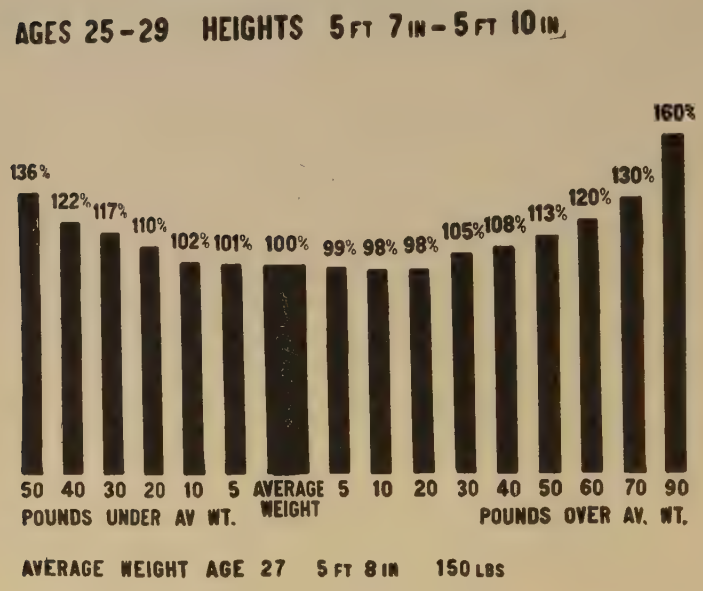

FIG. 77.—Average weight; age, twenty-seven years; 5 feet 8 inches; 150 pounds.

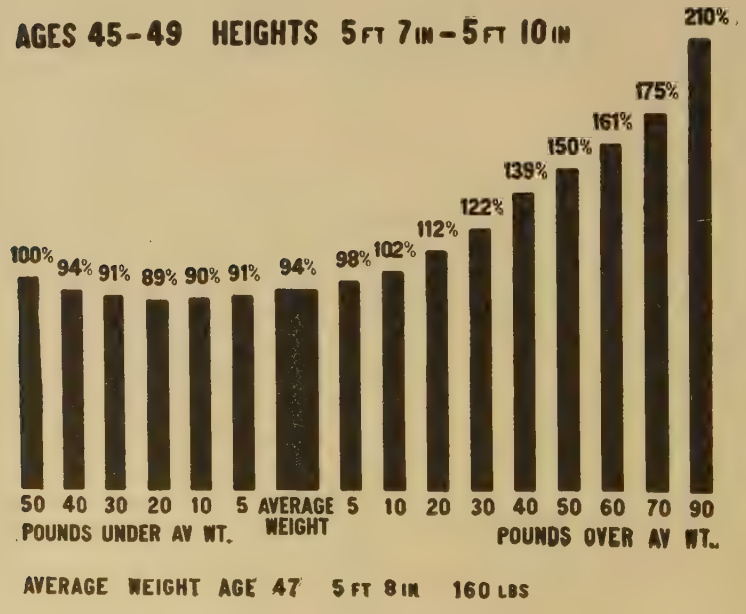

FIG. 78.—Average weight; age, forty-seven years; 5 feet 8 inches; 160 pounds.

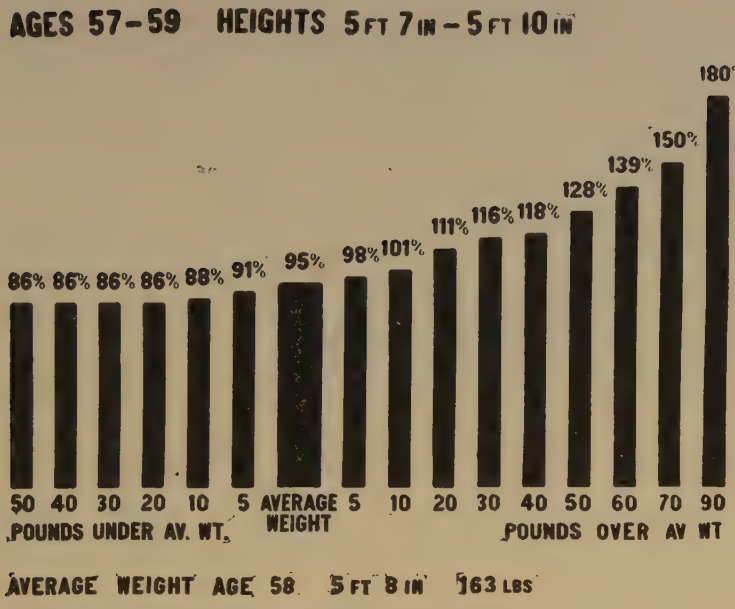

FIG. 79.—Average weight; age, fifty-eight years; 5 feet 8 inches; 163 pounds.

The percentages shown above indicate the death-rate at the designated age and weight as compared to the general death-rate among insured risks of the same age. For example, 120 per cent. means that in that particular weight group the death-rate was 20 per cent. higher than among all risks of the same age; 94 per cent. means that the death-rate in that weight group was 6 per cent. lower than among all risks of that age. Note that in the middle-aged and elderly groups there is approximately one point higher death-rate for every pound of overweight; that is, 40 pounds overweight shows 39 per cent. extra mortality, 50 pounds overweight, 50 per cent. extra mortality, etc. Also note that middle-aged and elderly lightweights show a very favorable death-rate, even lower than among those of average weight, indicating that the man of average weight is either overfed or underexercised, or both. It has been possible for the Life Insurance Companies to select a very favorable class of lightweight but impossible, in spite of their care in selection, to secure a favorable type of heavyweight Apparently all heavyweights, regardless of type are at a disadvantage as compared to the good lightweights. Lightweight, therefore, after full maturity, is an advantage unless it is due to some form of disease or malnutrition. "A lean horse for a long race" is a motto justified by Life Insurance experience. In early life the risk of overnutrition rather than undernutrition should be taken, but after thirty, watch your weight and keep it at the average weight for that age.

In the absence of disease it is a very simple matter to control the weight; that is, you must either increase your exercise to burn up your surplus fat, or you must reduce your fuel food so that your normal activities will burn up the surplus fat. The most concentrated fuel foods are sugar and fat, such as butter and cream. Bread and cereals are also high in fuel value. Eat lightly of such food, and in order that you may not suffer from hunger or a sense of deprivation, eat more freely of the foods low in fuel value, such as the following: Fruits and vegetables, especially cabbage, lettuce, celery, spinach, string beans, cucumbers, carrots, tomatoes, turnips and sea-kale.

TABLE OF HEIGHTS AND WEIGHTS BASED UPON THE REPORT OF THE MEDICO-ACTUARIAL INVESTIGATION, 1912, COVERING AN ANALYSIS OF 221,819 MEN AND 136,504 WOMEN.

TABLE OF AVERAGE HEIGHTS AND WEIGHTS.—MEN.

Age.	5 ft. 0 in.	5 ft. 1 in.	5 ft. 2 in.	5 ft. 3 in.	5 ft. 4 in.	5 ft. 5 in.	5 ft. 6 in.	5 ft. 7 in.	5 ft. 8 in.	5 ft. 9 in.	5 ft. 10 in.	5 ft. 11 in.	6 ft. 0 in.	6 ft. 1 in.	6 ft. 2 in.	6 ft. 3 in.	6 ft. 4 in.	6 ft. 5 in.
15	107	109	112	115	118	122	126	130	134	138	142	147	152	157	162	167	172	177
20	117	119	122	125	128	132	136	140	144	148	152	156	161	166	171	176	181	186
25	122	124	126	129	133	137	141	145	149	153	157	162	167	173	179	184	189	194
30	126	128	130	133	136	140	144	148	152	156	161	166	172	178	184	190	196	201
35	128	130	132	135	138	142	146	150	155	160	165	170	176	182	189	195	201	207
40	131	133	135	138	141	145	149	153	158	163	168	174	180	186	193	200	206	212
45	133	135	137	140	143	147	151	155	160	165	170	176	182	188	195	202	209	215
50	134	136	138	141	144	148	152	156	161	166	171	177	183	190	197	204	211	217
55	155	137	139	142	145	149	153	158	163	168	173	178	184	191	198	205	212	219

TABLE OF AVERAGE HEIGHTS AND WEIGHTS.—WOMEN.

Age.	4 ft. 8 in.	4 ft. 9 in.	4 ft. 10 in.	4 ft. 11 in.	5 ft. 0 in.	5 ft. 1 in.	5 ft. 2 in.	5 ft. 3 in.	5 ft. 4 in.	5 ft. 5 in.	5 ft. 6 in.	5 ft. 7 in.	5 ft. 8 in.	5 ft. 9 in.	5 ft. 10 in.	5 ft. 11 in.	6 ft. 0 in.
15	101	103	105	108	107	109	112	115	118	122	126	130	134	138	142	147	152
20	106	108	110	112	114	116	119	122	125	128	132	136	140	143	147	151	156
25	109	111	113	115	117	119	121	124	128	131	135	139	143	147	151	154	158
30	112	114	116	118	120	122	124	127	131	134	138	142	146	150	154	157	161
35	115	117	119	121	123	125	127	130	134	138	142	146	150	154	157	160	163
40	119	121	123	125	127	129	132	135	138	142	146	150	154	158	161	164	167
45	122	124	126	128	130	132	135	138	141	145	149	153	157	161	164	168	171
50	125	127	129	131	133	135	138	141	144	148	152	156	161	165	169	173	176
55	125	127	129	131	133	135	138	141	144	148	153	158	163	167	171	174	177

The average individual will find it very difficult to reduce weight by exercise alone. There is not time in which to do the strenuous exercise necessary to keep the heavyweight in trim; hence, food regulation must be the main dependence in keeping the civilized man and woman's weight within bounds. Exercise should, however, be increased as weight comes off in order to prevent "flabbiness."

The average individual requires about 2500 calories of food daily. From the following simple dietary an overweight who has no serious organic disease can bring down the diet as low as 1500 calories, forcing the body to contribute about 1000 calories daily of its own fat.

Breakfast.

Apple, small orange, or a half grapefruit, one or two eggs, thin toast, dry or very lightly buttered; coffee, with hot milk instead of cream, not more than one lump of sugar.

Luncheon.

Vegetable soup (no creamed soups), rye bread, bran bread or bran biscuit, or graham rolls—thinly buttered (one small pat only), lettuce and cheese salad, or lettuce and tomato, or fruit salad, French dressing.

Dinner.

Moderate helping of any roast of lean meat or non-fat poultry or fish, baked or broiled potato, any bulky vegetable (as lettuce, Swiss chard, parsnips, carrots, turnips, celery, oyster plant, cabbage, Brussels sprouts, tomatoes, salsify, Spanish onions, spinach), coffee, fruit dessert—grapefruit cocktail, oranges, or stewed fruits.

Exercise should, of course, be followed for its other beneficial effects as well as for weight reduction.

Where there is pronounced overweight it is well to weigh every few days in order to note the effect of the diet. It is a very simple matter to ease up on the fuel foods, substituting fruits and vegetables, and follow the effect of the diet by charting your weight on the blank provided for this purpose. There should be no effort at rapid reduction, but you should try and get off a few pounds each week.

The careful chewing, or rather tasting, of food until it naturally slides into the stomach will often tend to prevent overeating.

Feeding the Children.—It is especially important at the present time to guard our children against insufficient nourishment. The trend toward simple diet and household economies must not go to the extreme of restricting the diet of growing boys and girls. The tissues of the child are undergoing rapid changes and there is a high expenditure of energy, hence the fuel requirement of the child is greater in proportion to weight than that of the adult.

The average adult beyond thirty or thirty-five years requires food restriction and will benefit by it, but the growing child should be allowed to eat pretty freely, simply guiding the consumption of food along proper lines.

The following table prepared from various sources by the New York Association for Improving the Condition of the Poor exhibits a very conservative estimate of the food requirements of children.

FOOD ALLOWANCES FOR CHILDREN.

Age, years.	Calories per day. Boys.	Girls.
Under 2 years	900–1200	900–1200
From 2 to 3 "	1000–1300	980–1280
From 3 to 4 "	1100–1400	1060–1360
From 4 to 5 "	1200–1500	1140–1440
From 5 to 6 "	1300–1600	1220–1520
From 6 to 7 "	1400–1700	1300–1600
From 7 to 8 "	1500–1800	1380–1680
From 8 to 9 "	1600–1900	1460–1760
From 9 to 10 "	1700–2000	1550–1850
From 10 to 11 "	1900–2200	1650–1950
From 11 to 12 "	2100–2400	1750–2050
From 12 to 13 "	2300–2700	1850–2150
From 13 to 14 "	2500–2900	1950–2250
From 14 to 15 "	2600–3100	2050–2350
From 15 to 16 "	2700–3300	2150–2500
From 16 to 17 "	2700–3400	2250–2550

Note that the food requirement of a boy of sixteen years may exceed by one-third that of an ordinary sedentary business man, which is about 2500 calories. Children need plenty of fuel food, cereals, bread and butter, milk, cheese, eggs in moderation, but not a large amount of meat, certainly not more than once daily. The type of child must be considered, but on the whole the child's demands should be met as regards quantity and care taken that the diet does not become "finicky" or too narrow.

Fruit and green vegetables and a quart of milk daily should be insisted upon, and it is seldom that any undue gain in weight will be noticed. Such tendencies do not usually need watching until after age 30.

Alcohol.—The task of the Health Officer in educating the public on the effects of alcohol is far more simple today than it would have been even ten years ago. Not only is there now available a wealth of laboratory evidence and statistical evidence showing the effects of alcohol on the human body and upon society, but the public temper on this matter has greatly changed within the past few years, and under present conditions there is a disposition to abandon the traditional, cynical and self-indulgent attitude toward alcohol and listen to a presentation of the facts that science has made available. It is not necessary to dwell upon the association of alcoholic excess with crime and human misery; this is well known to every individual who has sufficient intelligence to respond to any form of education. There is no need to emphasize the evils of drinking to the point of intoxication.

It is the effect of the widespread, so-called moderate use of alcohol that should receive the attention of the health educator. On this subject there are available three sources of information: (1) The collected experience showing the influence of alcohol upon large masses of lives; (2) laboratory evidence showing the effect of alcohol on the human organism; (3) clinical observation of the effect of alcohol in the apparent causation of disease and its effect as a therapeutic agent. The medico-actuarial investigation showing the experience of forty-three American life insurance companies is a particularly important source of evidence as to the effect of alcohol on masses of lives. The chart on page 489 shows in a concise form the results of this experience. This general experience was checked by the individual experiences of a number of companies, in which it was shown that everywhere high mortality followed the flag of alcohol. Wherever there was temptation to alcoholic indulgence, as in occupations involving the handling or selling of liquors, the mortality was high, also with the increasing indulgence in alcohol there was shown an increased mortality. The experience of British life insurance companies is entirely consistent with that of the American companies, and there seems to be no question that a group of men using alcohol, all other things being equal, will show an increased mortality dependent upon the degree to which alcohol is used. Sometimes it is naïvely claimed that the extra mortality is not really due to the moderate use of alcohol but to the exces-

sive and increasing use of alcohol on the part of members of the drinking group. It seems to be forgotten that increasing use of alcohol is one of its pathological effects quite as much as nephritis, cirrhosis of the liver or cerebral degeneration. The point should be made clear that when a man enters a drinking group he deliberately assumes an extra risk, just as certain buildings are subject to an extra fire risk because of their structure. Certain buildings, notwithstanding this extra risk, may stand for many years, but a group of such buildings will invariably show an abnormal loss.

COMPARATIVE MORTALITY AMONG USERS OF ALCOHOL—FORTY-THREE AMERICAN LIFE INSURANCE COMPANIES, 1885–1908.

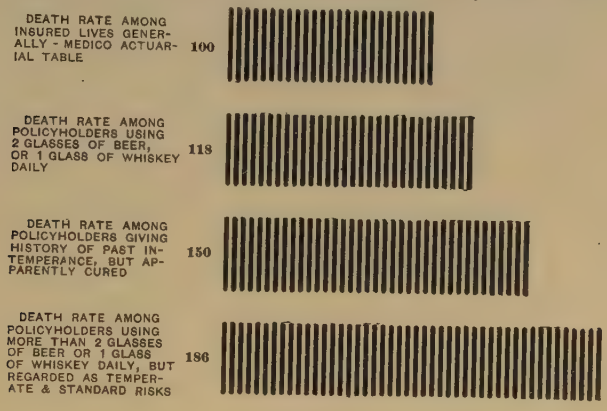
DEATH RATE AMONG INSURED LIVES GENERALLY - MEDICO ACTUARIAL TABLE
100
DEATH RATE AMONG POLICYHOLDERS USING 2 GLASSES OF BEER, OR 1 GLASS OF WHISKEY DAILY
118
DEATH RATE AMONG POLICYHOLDERS GIVING HISTORY OF PAST INTEMPERANCE, BUT APPARENTLY CURED
150
DEATH RATE AMONG POLICYHOLDERS USING MORE THAN 2 GLASSES OF BEER OR 1 GLASS OF WHISKEY DAILY, BUT REGARDED AS TEMPERATE & STANDARD RISKS
186

FIG. 80

When we turn to laboratory evidence in order to ascertain whether there is anything in the effect of alcohol on the human body that would justify the belief that the extra mortality found among large groups of users of alcohol is due to this disturbing effect on the human organism, we find abundant evidence warranting this interpretation of the statistical evidence.

The researches of Dodge and Benedict, of the Nutrition Laboratory of the Carnegie Institution, are particularly important not only because of the thoroughly unbiased scientific attitude of the investigators but because these experiences were checked by rigid control methods, and the results represent the records of instruments of precision which cannot be questioned as to the accuracy of their testimony

It is clearly shown, through Benedict's experiments, that alcohol belongs in the class of narcotic drugs; that even in moderate beverage doses it exerts a distinctly depressing influence first upon the lower reflex neural arcs of the spinal cord, the higher nervous mechanisms coming later under its influence. This is contrary to the findings of Kraepelin, yet it is consistent with more modern views of the functioning of the cerebrospinal system. It is not claimed by Benedict that the higher brain structures are not affected at the outset by

moderate doses of alcohol, but it is assumed that there is in such tissues a power which he terms "autogenic reënforcement" that enables them to resist this influence at the outset. There is some evidence from his experiences that as the lower reflex neural arcs pass from under the influence of alcohol the higher centers show its effects. The most important results of this investigation were the demonstrations that alcohol adds nothing to the organic efficiency of the circulation. There is an acceleration of the pulse-rate without any increase in its force. These researches revealed no evidence of the so-called stimulating effects but rather a decreased organic efficiency.

The literature on alcohol is, of course, enormous and there is much valuable physiological evidence available, especially in the report of the British Committee to the Central Board of Liquor Control entitled, "Alcohol, its Action on the Human Organism." Anyone who assumes the responsibility of educating the public on this matter should cast aside tradition, especially medical tradition, and carefully analyze the recent statistical and physiological evidence which places alcohol in the class of habit-forming narcotic drugs. It should be impressed upon the public that the bienaise, good fellowship, the joy in life which so many people endeavor to seek through the short cut of alcohol, can be obtained through the hormones that circulate in a body that is exuberant with health. Such psychic value as alcohol may possess is usually dearly bought. Men of the world who have used it without gross excess are frequently willing to confess that the "game is not worth the candle." It may properly be termed a "fake hormone."

With regard to light wines and beers the same principle holds good. It is simply a question of degree. We certainly would not recommend the use of paregoric as a substitute for morphin. If alcohol is indeed a habit-forming drug its total disuse should be advised. People often talk very glibly about the "harmlessness" of light wines, forgetting that the daily use of such wines may involve a greater consumption of alcohol than would be the case in moderate whisky drinking. A high ball is not stronger than many of these wines.

The third class of evidence, that derived from clinical observation, offers strong support to the conclusions derived from the more exact statistical and laboratory researches. The conclusions based upon general scattered observations are not always completely justified, but in the case of alcohol we may be sure that its gradual disuse by clinicians is scientifically sound. Even in the treatment of diabetes the researches of Higgins, Peabody and Fitz at the Carnegie Institution and at the Peter Bent Brigham Hospital have shown that it does not possess the peculiar virtues formerly ascribed to it. It is quite possible that alcohol has a limited range of usefulness in medicine, in which case there should be no fanatical abandonment of it as a therapeutic agent. Where other remedies will answer the same purpose, and especially where there is risk of its administration being followed by habit-forming tendencies, alcohol should be excluded.

The following resolution in the House of Delegates of the American Medical Association shows the present temper of the medical profession on this subject:

"WHEREAS, We believe that the use of alcohol is detrimental to the human economy; and

"WHEREAS, Its use in therapeutics as a tonic or stimulant or for food has no scientific value; therefore be it

"*Resolved*, That the American Medical Association is opposed to the use of alcohol as a beverage; and be it further

"*Resolved*, That the use of alcohol as a therapeutic agent should be further discouraged."

There can be no question but that the former widespread use of alcohol as a therapeutic weapon was based upon ignorance of its true physiological action.

Tobacco.—The widespread and increasing use of tobacco warrants the careful consideration of the public health officer.

In its book, *Health for the Soldier and Sailor*, the Institute has taken the position set forth in the following paragraphs:

"One hesitates to say anything against tobacco as an indulgence for the soldier because of the widespread campaigning for the tobacco fund. No one would wish to deprive the soldier of a comfort or solace that will help him to keep his poise or to stand the strain of war. But we believe that the soldier is entitled to know the danger of tobacco.

Let us see what hard-headed veterans of the recent war, active army surgeons who have handled men at the front, have to say. Major Lelean, of the British Army, who has published the lectures delivered by him at the Royal Army Medical College recently, has this to say:

"To take now the next item that comes in the ration list—tobacco. The effects of smoking on the heart and on the quality of the pulse are well shown by pulse-tracings. Without going into the question of such various objectionable ingredients in tobacco as nicotine and the more harmful furfural, one may say that excess of smoking, particularly of cheap cigarettes, produces tachycardia, muscular relaxation and diminution of visual acuity. These conditions result in "shortness of wind," which is bad for marching and produce muscular tremor and loss of effective sight which it need scarcely be said are worse for shooting. Tobacco, like alcohol, has certain compensating advantages. The mild narcotic effect of tobacco in moderation is not apparently attended by deleterious action on habitual smokers. Seeing that the allowance provides only two pipefuls a day it can do a man no harm to smoke one pipeful when he reaches camp and the other just before he turns in at night; the soothing effect is then most beneficial."

Again he says:

"Alcohol should be forbidden on the march; it lowers blood-pressure and causes rapid heat production without corresponding tissue repair. Smoking should be forbidden; it causes thirst, tremor and tachycardia (rapid heart)."

In the London *Lancet* for August 18, 1917, there are presented the results of experiments by Captain John Parkinson, of the Royal Army Medical Corps, and Dr. Hilmer Koefod, of Harvard, U. S. A., on "The Immediate Effect of Cigarette Smoking on Healthy Men and on Cases of Soldier's Heart."

"In the present war heart disturbances characterized by breathlessness after exertion, pain in the chest, rapid, irregular heart action, giddiness and exhaustion are quite common.

"In some cases valvular disease of the heart (V. D. H.) is found and the soldier is discharged, but in others no organic defect can be discovered, and these are classified in the Army Medical Service as D. A. H. (disordered action of the heart) and are termed "soldier's heart." The experimenters summarize their findings as follows:

"These observations show that in health the smoking of a single cigarette by a habitual smoker usually raises the pulse-rate and blood-pressure perceptibly and these effects are a little more pronounced in cases of 'soldier's heart.' Moreover, the smoking of a few cigarettes can render healthy men more breathless on exertion, and manifestly does so in a large proportion of these patients.

"Excessive cigarette-smoking is not the essential cause in most cases of 'soldier's heart,' but, in our opinion, it is an important contributory factor in the breathlessness and precordial pain of many of them."

The results of these experiments are exactly in line with those reported by Dr. George J. Fisher, physical director of the International Committee of the Young Men's Christian Association in his interesting book *The Physical Effects of Smoking*.

A number of careful experiments were made on a group of fifteen young subjects, physical directors in normal condition of health, and engaged in vigorous exercise daily. Seven were non-smokers and eight classed as "moderate smokers." The experiment covered investigation of the heart-rate after exercise, the precision of neuro-muscular movement and accuracy in baseball-pitching.

The results of these various experiments are summarized as follows:

1. Smokers have a normal heart-rate higher than non-smokers.

2. Smoking causes a delay in the return of the heart-rate to normal after exercise. As evidenced in this study, this delay is 7.9 minutes for non-smokers and 6.8 minutes for smokers.

3. Equilibrium of heart-rate is not established in habitual smokers, *i. e.*, the body does not become accustomed to smoking, for there is but a slight difference in the length of time of the return of the heart-rate to normal between smokers and non-smokers.

4. To the writer the most important conclusion as shown by the work is that:

(*a*) In 74 tests out of 118 smoking tests, or 62.72 per cent., the heart-rate was increased and did not return to normal at the fifteenth minute. In 72 out of 74 tests without smoking, 97 per cent. of all the tests taken, the heart-rate returned to normal in less than fifteen minutes, the average time being only five minutes.

(*b*) The average heart-rate at the fifteenth minute was 11.2 beats greater than the average normal heart-rate.

These experiments are exceedingly convincing. They are also exceedingly original. They show that the smoker apparently does not become habituated to the use of tobacco, that exercise disturbs him more than the non-smoker, that physical work causes more of a disturbance in organic function in those who smoke than in those who do not. Apparently, therefore, athletic coaches have been wise in asking their athletes to give up smoking when training. We would imagine also that the non-smoker, other things being equal, would make the better workman, for he can work with less disturbance:

1. All smokers showed a loss in physical precision immediately after smoking.

2. Five of the seven smokers showed improvement during the interval when not smoking.

3. Smokers showed a greater lack of neuro-muscular control after exercise than non-smokers.

4. Non-smokers showed slight gain in precision during smoking tests. This, in the mind of the writer, is probably due to greater experience with the apparatus.

6. All non-smokers showed improvement in neuro-muscular control after exercise.

7. Some of the subjects in both classes were affected more than others. This was more pronounced in the tests taken with non-smokers.

8. General effect of smoking on the non-smokers also produced other serious results, in some cases physical discomfort.

In test A, during which one cigar was smoked, the smokers showed a loss of 11 per cent. in accuracy when pitching a baseball after smoking.

In test A, during which one cigar was smoked, the non-smokers showed a loss of 13 per cent. in accuracy when pitching a baseball at a target after smoking.

The non-smokers show an increase of 2 per cent. over the smokers in loss of accuracy after smoking.

The average loss in accuracy during test A for both smokers and non-smokers is 12 per cent. after smoking.

In test B, during which two cigars were smoked, the smokers showed a loss of 11 per cent. in accuracy when pitching a baseball at a target after smoking.

The non-smokers in test B showed a loss of 18 per cent. in accuracy when pitching after smoking.

The non-smokers show an increase of 7 per cent. over the smokers in loss of accuracy after smoking.

The average loss in accuracy after smoking during test B, for both smokers and non-smokers, is 14.5 per cent.

In test C, during which no cigars were smoked, the smokers showed an increase in accuracy of 9 per cent. after a delay of thirty minutes, equal to the time taken in smoking a cigar.

In test C the non-smokers showed an increase in pitching a baseball accurately without smoking of 10 per cent.

The non-smokers showed a gain of 1 per cent. over the smokers in accuracy of pitching.

The average gain in accuracy of pitching during test C for both non-smokers and smokers is 9.5 per cent.

1. The foregoing experiments have proved conclusively that smoking does actually reduce a man's accuracy in pitching a baseball.

2. The smoking of a single cigar will affect a man's accuracy in pitching and two cigars increase this effect.

3. In tests during which there was no smoking the men improved in accuracy of pitching.

From this we see that the heavy use of tobacco (and there is grave danger of an exceedingly heavy use if the soldier is not warned) is a serious menace to the soldier and that even the moderate use is not without danger to his health and to his efficiency in marksmanship, bomb-throwing and other work requiring team work by brain and muscle. Naturally, if the solace of tobacco will keep the soldier from going insane or losing his control in short periods of strain it might prove of value as a veritable medicine for some, but the average soldier should not have tobacco showered upon him without a word as to its possible harmful effect upon the heart."

It is to be hoped that thoroughgoing laboratory investigations similar to those carried on by Benedict at the nutrition laboratory on the effects of alcohol will, in the near future, be undertaken with regard to tobacco, also that the statistical evidence will in due course be available from life insurance companies and other sources.

In the interval of such research those upon whom the responsibility falls for guiding the public are perfectly justified in taking the position that tobacco is a narcotic poison, that even its moderate use, as in the case of alcohol, is attended by the danger of increasing use, that it is not consistent with wise counsel to the public to encourage even the moderate use of such a drug, that the public should be encouraged to maintain a standard of health that is independent of these narcotic resources and attempted short cuts from life strain.

The average individual who first uses tobacco usually experiences profound poisonous effects. It is true that the nervous system subsequently becomes adjusted to this indulgence, but this is the case with all narcotics, even morphin. No physiologist would claim that the adjustment of the organism to large doses of morphin represents a favorable physiological condition. The same principle holds true with regard to tobacco as with any other indulgence. It is sought as a substitute for hormones, as an escape from life strain; this support and this escape should be sought in constructive ways and not through the destructive influence of drugs.

The most effective stand for the health educator to take is one of frank and fearless presentation of the truth. It is not necessary to preach against the use of tobacco but simply state the facts as to its possible injury so that those who use it may clearly understand the

risk they are assuming. The health educator who shrinks from disturbing a pet indulgence or from arousing popular prejudice is recreant to his task. The public should have the facts without regard to where they cut and the responsibility is then on the public for persistent violations of health laws.

One drop of nicotin on the unshaved skin of a rabbit has been known to cause death. There is probably enough nicotin in the average cigar to kill a man if he got the full dose. Nicotin in the rapidity of its fatal effects resembles prussic acid. The widespread toying with such a powerful poison is not a laughing matter; it is entirely worthy of careful attention of the public health officer, especially as the tide rises against alcoholic indulgence. It may be that tobacco indulgence may arise as a substitution factor if its possible harmful effects are not more clear. As in the case of alcohol, most men who smoke at all smoke too much, that is, smoke to a degree, which, in the long run, will probably prove distinctly harmful and life-shortening.

The following are extracts from a health letter approved by the Hygiene Reference Board of the Life Extension Institute.

What It Costs to Smoke Tobacco.—The smoke bill, like the alcohol bill, grows apace in this country. In 1880 the annual per capita consumption of tobacco in the United States was about 5 pounds, but in 1914 it had risen to more than 7 pounds. In the United Kingdom the per capita consumption is about 2 pounds, and there has been no material increase in recent years.

The cigarette bill, in particular, has grown enormously, having more than doubled in five years, while there has been a slight increase in the consumption of cigars, smoking tobacco, chewing tobacco and snuff, as shown in the following table:

REPORT OF THE COMMISSIONER OF INTERNAL REVENUE (WITHDRAWALS TAX PAID FOR CONSUMPTION OF MANUFACTURED TOBACCO PRODUCTS DURING THE PAST FIVE YEARS).

Fiscal year.	Cigars.	Cigarettes.	Tobacco, chewing and smoking.	Snuff.
	Number.	Number.	Pounds.	Pounds.
1913	8,732,815,703	14,294,895,471	404,362,620	33,209,468
1914	8,707,625,230	16,427,086,016	412,505,213	32,766,741
1915	8,030,385,603	16,756,179,973	402,474,245	29,839,074
1916	8,337,720,530	21,087,757,078	417,235,928	33,170,680
1917	9,216,901,113	30,529,198,538	445,763,206	35,377,751
Total	43,025,448,179	99,095,112,076	2,082,341,212	164,363,714

The annual expenditure for tobacco in this country is at least $1,200,000,000, a huge sum to go up in smoke.

Effects on Animals and Man.—Nicotin at first slows the heart and increases the blood-pressure, subsequently the blood-pressure is lowered and the heart action becomes rapid. The effect on the brain is essentially narcotic, or depressing. Those whose thoughts flow more readily under the use of tobacco are simply in the same case with any

other habitué whose thoughts cannot flow readily except under the accustomed indulgence. That a sound and healthy man, who has never been accustomed to the use of tobacco, can do better mental or physical work with tobacco than without it has never been shown. Indeed, experiments show the contrary.

Some of the unfavorable effects that have been noted by physicians are as follows:

Heart and circulation: Disturbance of the blood-pressure, rapid heart action, shortness of breath, palpitation of the heart, pain in the region of the heart.

Acid dyspepsia, insomnia, catarrhal conditions of the nose, throat and ear, and even blindness, have followed the excessive use of tobacco.

In a majority of instances, tobacco is evidently used for its drug effect. Snuff-taking and the chewing and smoking of tobacco are all practised largely for their narcotic influence. Tobacco deprived of nicotin has never been popular, notwithstanding the efforts of the French and Austrian governments to make it so.

Its narcotic influence, however, is so slight, as compared to opium, alcohol, cocaine, etc., that the habit is less demoralizing than other narcotic habits, and can usually be readily broken off. As smoking is often practised by men of high moral character, there is practically no moral restraint upon the smoker as a check to increasing indulgence.

What Can Be Said in Favor of Tobacco.—A careful examination of the evidence does not show that tobacco will do anything for the steady support and upbuilding of health. Such solace and surcease as it may bring would better be secured through healthful forms of recreation that will cost nothing in physical deterioration and cost even less in actual money.

The mistake that men make is in tacking alcohol and tobacco on to nearly every form of game or recreation that they follow, instead of seeing what they can get out of the game itself. The sums that many men with small incomes spend on tobacco would, in the course of a year, pay for many wholesome recreations which are considered beyond the means of the average worker.

CARE OF THE TEETH, TONSILS, ETC., TO AVOID OR REMOVE FOCAL INFECTION.

The work of Billings, Rosenow, and the Mayos has done much to uncover the importance of microörganisms as causative factors in chronic organic disease as well as in acute surgical affections.

Probably nothing would contribute more effectually to put out of business the various pseudoscientific cults and "isms" than a thorough dissemination of knowledge on this subject. With the definite causes of disease revealed the mystery monger is hard-pressed to justify his "laying on of hands" and his relation of all the ills that flesh is heir to to some mysterious cause which only he or his cult is competent to remove. The man with a magic liniment is made ridiculous when the true cause of rheumatism is revealed. Even a comparatively harmless and sometimes helpful physical culturist must take heed that he is

not engaged in a sisyphean task of trying to "build up" by strenuous exercise a dangerously infected body.

As various diseases are placed in the group of conditions which may be caused by focal infection we come closer to the realization of the fact emphasized in previous chapters, that disease is not an entity and that among the definite concrete causes of physical degeneration or impairment bacterial infection is the most important. A due sense of proportion must, of course, be observed in this matter. Various factors other than infection may contribute to lower the bodily resistance, and we may have such conditions as pyorrhea as a result rather than a cause of ill health. Such cases call for sound judgment in their government. Every phase of the individual activities, diet and exercise should be considered while at the same time effort should be made thoroughly to correct the mouth conditions by surgical and local means so far as this may be possible.

People vary in their reaction to these focal infections. On the other hand the focal infections vary widely in their virulence and in their selective location. This selective localization of infection is a striking illustration of the complex and insidious struggle that is continually going on beneath the surface.

Focal infection or the point at which microörganisms are collected ready to invade the body and localize in some region where resistance is lowered may be an important factor in causing the following diseases: Acute rheumatism, chronic rheumatism (so-called arthritis deformans), ulcer of the stomach, duodenal ulcer, functional and organic heart disease, acute and chronic kidney disease, diabetes and diseases of the pancreas, infection of the cavities of the face and head, brain abscess, anemia, Hodgkin's disease, neuritis, arterial changes.

It is well to remember that we have not solved the problem of mouth infection when we bring about the effectual use of a tooth-brush. There are people who have faithfully and properly used their tooth-brushes for many years and yet have not escaped infection because of some other fault in hygiene that has lowered their resistance. The preservation of the teeth and their protection from caries is, of course, a matter of immense importance in preventing mouth infection. It is probable that future generations will have less trouble in this regard than adults of the present day who have been victims of well-intentioned and highly skilled workers in dentistry who have unwittingly sealed infection into many a tooth which might better have been removed. Even yet tradition still sways the dental profession to some extent and teeth that are a constant menace to the body are nursed and treated at some risk to the individual.

In the examinations of the Institute it has been our experience that few mouths are free from root abscesses. In a series of 1800 *x*-ray cases 62 per cent. of the individuals examined showed root infection. No doubt in some cases the infection is non-virulent, but there is always a presumption that there is at least a slowly operating unfavorable influence from such a focus.

Arteries do not harden and tissues and cells change into the final condition of senility without definite cause and these infections must all have their contributory influence. Hence, the fact that a patient does not suffer from rheumatism and is free from other prominent symptoms of focal infection is no valid reason for regarding a root abscess as of no importance.

A very competent dentist recently expressed some skepticism as to the menace of these abscesses which had existed for many years, stating that he had known many people who apparently had suffered no ill-effects from them. I asked him if these people were not growing old gradually and showing signs of physical failure. Always this basic fact seems to be ignored by people who demur to the indictment that is brought by hygienists against various unhygienic practices or preventable physical defects. The fact that a man is not ill in the ordinary sense of the word is entirely satisfying to such people; their imaginations do not rise to the point of visualizing a retardation of the process of aging or of the attainment of a late maturity that is free from the restrictions, handicaps and minor miseries that are the common lot. And as an answer to all such people we have the incontrovertible fact of death coming to all who do not die by accident, as a palpably pathological state, however it may be masked by the euphemism "senility" or "natural decay."

This great menace of focal infection is the most powerful argument for periodic physical examination. As a primary step in personal hygiene the body should be thoroughly searched for such infection. It staggers the imagination to reflect upon how much misery and premature death would be prevented if every individual in the community would have a complete *x*-ray of the jaw and a thorough examination of the head cavities. Septic tonsils should be sought for, also the intestinal tract should be investigated as a possible source of subinfection. There is excellent scientific support to the theory that bacteria can travel directly through the tissues and do not have to proceed through the lymphatics and blood stream.

The health officer should impress upon the people that just as it is necessary to search the community for centers of infection, for sources of water pollution, for sources of milk infection, etc., so is it important to search the body for centers of infection, for structural weaknesses, for the manifestations of faulty hygiene. It should, however, be impressed upon the people that a life must be considered as a whole and that there is required not merely a physical examination of the body, but also a consideration of the psychic relationships, the environment, the mental hygiene, the activities of the individual, his family and personal history. All these factors together with the present physical condition should be considered and the needs of the individual interpreted by a study of the complete evidence. The ideal that we should struggle for is the perfect adjustment of the individual to his environment. This, of course, can never be attained but we should work toward it rather than rest content with the limitations imposed by tradition.

CHAPTER XX.

ADDITIONAL PRACTICAL POINTS IN PERSONAL HYGIENE.

By ARTHUR R. GUERARD, M.D.

Air is the first necessity of life. The air supply of the individual is of as much importance as his water or food supply, and good ventilation in the home thus becomes the first rule of personal hygiene. (See Chapter VII for methods.)

Living and working rooms should be ventilated both before occupancy and while occupied. The mere construction of the proper kinds of buildings, with ideal window-space and ventilating apparatus, does not insure ventilation unless these are actually used.

The most important features of ventilation are motion, coolness and the proper degree of humidity and freshness.

Persons who are unaccustomed to ventilation, and consequently oversensitive to drafts, should avoid exposure while changing their habits; and it is never advisable that a person in a perspiration should sit in a strong draft. But after even a few days of habitual enjoyment of air in motion, with gradual exposure, the likelihood of colds is greatly diminished; and persons who continue to take advantage of moving air soon become almost immune to colds.

The germs are almost always present in the nose and throat. The usual cold is produced by the exposure to a draft plus the presence of germs and a lowered resistance of the body. Sailors who are constantly exposed to all kinds of rough weather never take cold until they come ashore.

The importance of coolness is almost as little appreciated as the importance of motion. Heat is depressing. It lessens both mental and muscular efficiency. The temperature of living and work rooms should not be above 70° F., and for people who have not already lost largely in vigor by living in overheated rooms, and for those who are actively employed, a temperature of 5° to 10° lower is preferable.

An accumulation of house dust should be avoided. The dust should be removed, not by a feather duster which scatters the dust into the air, but by a damp or oiled cloth. Dust-catching furniture and hangings of plush, lace, etc., are not hygienic. A carpet-sweeper is more hygienic than a broom, and a vacuum-cleaner is better than a carpet-sweeper; hence, removable floor rugs are hygienically preferable to fixed carpets.

The air that is breathed should be sunlit when possible. Most

bacteria do not long survive when exposed to the direct rays of the sun. Lack of light also has an indirect effect in favoring uncleanliness and in being usually accompanied by faulty ventilation.

Outdoor Living.—While the proper ventilation of houses is necessary to health, this alone cannot be depended upon. Outdoor life is an essential part of personal hygiene. The best ventilated house is not as good as outdoor air. Those who spend much of their lives in the open enjoy the best health and live longest.

Climate, of itself, is a secondary consideration. Not everyone can select the finest climate in the world to live in, but the main advantages of fresh air can be had in almost any locality. Even in a city outdoor air is, under ordinary circumstances, wholesome and invigorating.

The common prejudice against damp air greatly exaggerates its evils. While moderate dryness of air is advantageous, it is generally more healthy to live in damp, even foggy air out of doors, than to live shut up indoors.

Pupils in outdoor and open-window schools are not only kept more healthy, but learn more quickly than those in ordinary schools. Tuberculous children even in an outdoor school are found to make more rapid progress in their studies than normal children in a badly ventilated school.

Health officers should instruct the public in this matter, and parents should require ample fresh air for their children when at school; and they should also insist on outdoor playgrounds.

Whenever practicable, outdoor recreation is preferable for all persons to indoor recreation. And for the same reason outdoor occupations, when possible, are preferable to indoor occupations, such as working on a farm rather than in a factory.

Outdoor Sleeping.—Unfortunately most people cannot live out of doors, and many are so situated that they cannot even secure proper ventilation indoors. But almost everyone can control his own air supply at night when sleeping. As about one-third of life is spent in bed, and a large majority of persons live confined lives during the day, it is important for most people to obtain sufficient fresh air at night.

It is the universal testimony of those who have slept out of doors that the best-ventilated sleeping room is inferior in healthfulness to an outdoor sleeping porch, or window tent.

For generations outdoor sleeping has occasionally been used as a health measure in certain favorable climates. But only in the last two decades has it been used in ordinary climates and all the year round. This practice has now been introduced for the treatment not only of tuberculosis but also of nervous troubles and of other diseases, including pneumonia. Lately the value of outdoor sleeping for *well persons* of all classes, infants and children as well as adults, has come to be recognized.

Outdoor sleeping increases the power of resistance to disease, and greatly promotes physical health and efficiency.

Many persons are still deterred from sleeping out by a mistaken fear of night air and of the malaria which they imagine the night air may bring. Today we know that malaria is communicated by the bite of the anopheles mosquito and has nothing to do with the air. When necessary the mosquito can be shut out by screens which do not exclude the night air. The truth is that night air, especially in cities, is distinctly purer than day air on account of the fact that there is much less traffic at night to stir up dust.

It is important, in any sleeping balcony, to be protected from the wind by a sash on one or two or—in very windy places—three sides.

A roll curtain (preferably rolling from the bottom) can be arranged on the open side or sides, to be used in case of storms only. In cold weather a thick mattress, or two mattresses, should be used. The body should be warmly clad, and the head and neck protected by a warm cap or helmet or hood. To prevent the entrance of cold air under the bedclothes, one or more blankets should be extended at least two feet beyond the head, with a central slit for the head. Early awaking by the light may, if necessary, be prevented by touching the eyelids with burnt cork, or by bandaging the eyes with a black cloth. Sheets should be well warmed in the winter time before being used by means of a hot-water bag, flatiron or soapstone. Blankets next to the skin are not hygienic.

When a sleeping porch is not available, an inward window tent can always be had which puts the sleeper practically out of doors, and at the same time cuts off his tent from the rest of the room.

An outdoor tent must be kept well opened if it is not to fail of its purpose. The canvas, of which tents are made, is of tightly woven fabric and impervious to air and thus affords no ventilation unless sufficiently open.

Deep Breathing.—Deep breathing is of great benefit to persons who are shut in most of the day. If they are taught how to breathe deeply and will seize the opportunity, whenever it offers, to step out of doors and take a dozen deep breaths, they can partly compensate for the evils of indoor living.

In ordinary breathing only about 10 per cent. of the lung contents is changed at each breath. In deep breathing a much larger percentage is changed, the whole lung is forced into action, and the circulation of the blood in the abdomen is more efficiently maintained, thus equalizing the circulation throughout the body. The blood-pressure is also favorably influenced, especially when increased pressure is due to nervous or emotional causes.

Breathing exercises should be deep, slow, rhythmic and through the nose, not through the mouth. Muscular exercises stimulate deep breathing, and in general the two should go together. But deep breathing by itself is also beneficial if very slow. Forced rapid breathing is comparatively useless, and indeed may be positively harmful. Oxygen is absorbed only according to the demand for it in the body and not according to the supply.

Cleanliness.—Cleanliness is to the body what oil is to the machine; it preserves from rust. The best-kept machines last longest. It need not be proved that uncleanliness must invariably breed disease. Bathing is necessary for cleanliness. The hands, face and fingernails should be kept clean, especially before meals. Any cut or abrasion of the skin or mucous membrane may allow bacteria to enter when the spot is dirty or is touched by dirty hands.

The need of cleanliness is particularly great for those who work in factories, mines and other places where dirt is likely to be carried to the mouth by the hands. The larger majority of the infections get a foothold in this way.

A person who does not bathe daily is almost certain to carry on his skin some perspiration which, while he may be unaware of it, gives forth an offensive odor that may be noticed by others. Perspiration prior to bathing promotes cleanliness. The most beneficial method of securing perspiration is by vigorous exercise; but when a person cannot or will not take exercise, perspiration can be induced by hot baths. Such extreme measures ought not, however, to be resorted to too often. How often will depend on corpulence and other circumstances of each individual. Sweating may be overdone, and should never be pushed to the extent of exhaustion.

Some of the most serious and widespread infections are those from the venereal diseases, with a whole train of terrible consequences, such as blindness, joint diseases with heart complications, peritonitis, paralysis and insanity. They can only be avoided by living a life of hygienic cleanliness, not only of body but mind. From even the narrowest interpretation of personal hygiene, a decent life is necessary for the maintenance of health. This is a subject about which most people are extremly ignorant and need instruction.

Care of the Skin.—The skin is not merely a covering and protection for bone, muscle and other tissue against cold and infection, but it is a very important organ in close relationship with the internal organs. It is a part of the heat-regulating machinery of the body; and it is the organ of secretion and excretion, though it is of very little importance as an organ for the removal of waste products. Its main function is to regulate the heat of the body. Care of the skin, therefore, is essential for health, not only for cleanliness but to train it as an organ to do its main work, that of heat regulation. In his artificial mode of living, man has become an indoor animal and he has further modified the condition of his skin by wearing clothing often of a closely woven material which shuts the skin off from the light and air and protects it so effectively from the changes of temperature that the original vigor of the skin is lost. Fully to restore this primitive vigor is not possible under civilized conditions, but much may be done by proper exercise and skin training, by judicious exposure to light and air and graduated cold bathing, and by wearing suitable clothing.

Bathing.—1. **Air Baths.**—An air bath promotes a healthy skin and aids it in the performance of its normal functions. Not every one can

visit air-bath establishments or outdoor gymnasia or take the modern nude cure; but any one can spend at least a little time in a state of nature at home. The whole body should be exposed to light and air for a certain time each day, while at the toilet or before retiring, care being taken not to let the body become chilled. This applies to persons free from organic disease whose bloodvessels and nervous system can respond to such measures. The sensitive skin that cannot stand a draft is thus brought nearer to the primitive resistant condition.

2. **Cold Baths.**—This is still further obtained by the tub bath for the purpose of skin training, entirely apart from the cleansing of the skin. The cold bath habit is common among the better classes in England and America and ruddiness and fine complexions are in no small part due to the custom. The daily cold bath should be taken by everyone having the facilities and able to secure the after-glow or reaction which should follow if the bath agrees. The cold shower or sponge bath can be employed when the tub bath is not feasible. For many persons unable to take a cold bath without feeling chilly afterward, and for children, the use of hot water to sit or stand in while taking a cold shower or sponging will often prevent undue shock. Standing in about a foot of hot water the body may be briskly rubbed with a wash cloth wrung out of water at about 80° F. and reduced day by day until it is down to 50° F. Following this the cold douche shower or effusion may be taken, beginning at 90° F. until 50° F. is reached, or until an agreeable reaction ceases to follow.

Persons unaccustomed to cold baths should begin to take them in summer and so continue them throughout the year. They are very valuable for many of those who think them impossible; namely, those who take cold readily and frequently, those below par and needing tone. The cold water should be applied to the skin only for a minute or two and followed by brisk rubbing with a coarse towel. For young children, old persons unaccustomed to cold water, and those with weak hearts or kidney disease, or for women during menstruation, or in the later months of pregnancy, cold baths are inadvisable. Also cold baths are harmful to persons fatigued with muscular exertion and to those excessively hot, but may be taken by healthy persons when warm with moderate exercise. Cold baths should be taken before breakfast or at least three hours after eating and in a warm room.

3. **Warm Baths.**—Cleanliness requires that a warm bath should be taken by the ordinary person at least twice a week. Pure soap and warm water form an emulsion with the fatty matters obstructing fat glands and hair follicles and prevent the clogging of these so-called "pores," which so often permits an infection to recur and results in acne and other skin eruptions.

The tepid or neutral bath (80° to 90° F.) has no special effect apart from cleansing, although it is restful. It is suitable for invalids, the elderly, convalescents, and those who do not react well to cold baths. It may be taken at any time of day, but preferably before meals or at bedtime.

The warm bath (90° to 100° F.) is the appropriate one for infants, and to prevent sleeplessness in adults when taken just before bedtime. It is also excellent after severe muscular exercise to relieve soreness and stiffness of joints and muscles. It should not be employed until two or three hours after meals. It is unwise to venture into the cold air immediately after a warm bath.

The hot bath (105° to 110° F.) is unsuitable, except for the strong, as it is depressing to the circulation. It should only be used at night or when the bather is to stay in a warm atmosphere, and not after meals. At bedtime the hot bath may, however, cause sleeplessness unless a cold cloth is kept on the head during the bath. The hot bath is very valuable in preventing colds after exposure and chilling and to produce sweating in many disorders in which it is necessary to open the pores of the skin.

4. **Turkish Baths.**—The Turkish bath consists of a hot air bath (120° to 170° F.) for ten to thirty minutes, followed by a hot shower bath, then shampooing and general massage in moist air (100° to 110° F.), and finally by a warm shower bath, changing to cold, with thorough rubbing and drying and rest for half an hour in blankets.

In the Russian bath moist instead of dry air is used in the beginning, which is more oppressive. Turkish and Russian baths are unsafe for persons with weak hearts or who are very fat. They are useful in the first stages of a cold, but the patient must not be exposed to the cold air afterward or there will be decided danger of bronchitis and other pulmonary troubles. Muscular or joint stiffness, following severe physical exertion and some forms of rheumatism, are much benefited by the Turkish bath.

5. **Outdoor Bathing.**—The pure air, the exercise, the sunlight, the stimulating effect of the waves and salt (in sea water), and, in addition, the pleasure, make this form of cold bath (usually from 60° to 75° F.) particularly healthy. It is, however, often grossly abused. The effect of remaining in cold water for a considerable time causes an immense loss of body heat and consequent drain upon the vitality. Sea bathing is exhausting to those who stay in the water too long. This applies especially to children who alternately play out of the water while clothed in wet bathing suits and occasionally return into the water, or wade with bare feet in cold water while their heads are exposed to the burning sun—a combination that favors sunstroke. Fat people can often stay in cold water for some time without ill effect. The length of time which it is safe to stay in cold water depends entirely on its temperature—anywhere from two to twenty minutes. The stay should never be so long as to cause blueness of the lips and fingers, chattering teeth or chilliness afterward. The head should always be wet before plunging into cold water either by diving or dipping the head. Those accustomed to cold water may bathe before breakfast to advantage; others should wait until three hours after meals. Sudden and unexpected deaths among bathers and swimmers are frequently due to either special weakness of the

heart or overexertion. The dangers of "cramps" are probably much exaggerated. Those who are subject to fainting, palpitation or known disturbance of the heart, and the elderly not habituated to cold water, should refrain from bathing out of doors, as also those likely to suffer from cold indoor bathing, as stated.

Care of the Complexion.—There is an unfounded fear of the effect of soap on the skin of the face and scalp. As an ordinary hygienic measure the face should be washed once a day with warm water and a good quality of soap. Care should be taken not to irritate the skin by too vigorous rubbing and the soap should be carefully rinsed off and the skin thoroughly dried after final bathing in cold water. The face and hands should not, ordinarily, be too frequently washed during the day in cold weather and care should be taken always to thoroughly dry the skin and avoid chapping.

About once a week it may be well to rub cold cream on the face very lightly and then carefully rub it off with a soft towel, subsequently washing the face with hot water and soap and finally washing with cold water. All such directions are subject to personal peculiarities and diseased conditions where soap and water may prove irritating, but for the average skin they hold good.

Pimples showing pus should be punctured with a sterilized needle, and the parts afterward bathed with saturated boric acid solution and very hot, moist cloths applied. Vigorous squeezing of blind pimples should be avoided. Blackheads may be extracted with a comedo extractor similar to a watch key, followed by bathing and treatment as above. Steaming the face is sometimes of value.

Care of the Scalp.—The scalp being a part of the skin, what has been said as to cleanliness applies with double force because the hairy covering invites the collection of dirt. Shampooing often enough to keep the scalp and hair clean is a hygiene measure to be encouraged, but very frequent washing is harmful. Temporary dryness of the hair may result which can be relieved by rubbing the hair and scalp with alcohol in which there is dissolved three to six teaspoonfuls of castor oil to the pint; it has also a certain antiseptic value. Too frequent washing of the scalp keeps the sebaceous glands open and tends to increase the flow of oily secretion (sebum). Oil is not needed to nourish the hair; the hair as it emerges from the skin is dead tissue and cannot be nourished. The fats poured on it from the sebaceous glands merely keep it glossy. Shampooing with tar soap or sulphur soap is a good measure for dandruff. The disease of which this common affection is the sign is thought to be caused by germs and sometimes, when excessive, may result in baldness. Baldness may also be due to wearing close-fitting, ill-ventilated hats and by deficient blood supply to the hair, as well as by excessive dandruff. Gray hair is caused by loss of pigment and the presence of air bubbles that occupy spaces in the hair. There is no cure; the best preventive is general care of the scalp as above outlined and general hygiene. Heredity is a factor in both baldness and gray hair.

Several skin diseases caused by parasites may be conveyed by barbers to their customers by means of their instruments, hands, towels, etc. Among these are barbers' itch, ringworm, boils and even carbuncles. The only way to avoid such infections with certainty, is for the patron to furnish his own brush and comb, shaving-soap, cup and brush, and see to it that the barber cleanses his scissors and razor with alcohol and water and uses a clean cloth. Notwithstanding the improved methods in barber shops much infection is still spread, especially that of dandruff.

The *finger-nails* should be trimmed so as to follow closely in outline the contour of the finger; the toe-nails should be cut straight across to avoid pressure on them by the toe of the boot which may result in in-growing toe-nail.

Clothing.—Tight clothing, and the constriction from rigid or tight corsets, belts (the latter in men as well as in women), tight neckwear, garters, etc., interfere with the normal functions of the organs they cover. All such constriction should be carefully avoided. Only the minimum amount of clothing that will secure warmth should be worn.

In regard to underclothing, there are two factors of importance: First, the property of retaining heat. Of the three fabrics most frequently used for clothing, wool, cotton and linen, wool is the greatest non-conductor and therefore retains heat most effectually. But for this reason woolen garments require the least exercise of the temperature-regulating apparatus of the body. The second factor is the power of absorbing moisture. While wool is also highly absorbent of moisture, it does not give off moisture quickly enough. Hence, if worn next to the skin, it becomes saturated with perspiration, which it long retains to the disadvantage of the skin. Consequently woolen clothing is best confined to outer garments, designed especially for cold weather. Cotton, on the other hand, does not absorb moisture so readily, is a better conducting material and drys more rapidly. Linen is about on a par with cotton as regards power of absorption of moisture and retention of body heat. The underclothes throughout the year are best made of cotton or linen. In winter merino, that is, a mixture of cotton and wool or "double-deck" linen and wool, may be worn by those who object to wool alone. The linen mesh makes an excellent fabric for warm weather, for it imparts a sense of coolness to the skin, but it is more expensive than cotton.

As to color, the more nearly white the clothes the better. This is especially true in summer, though there is believed to be some advantage in white at all times. Undergarments dyed in bright hues are undesirable, as the anilin colors used often irritate the skin and produce eruptions. The same effect is sometimes caused by colored stockings. The stockings should be changed frequently, especially if one perspires freely. The feet should then be soaked in hot water and dusted over with pure boric acid every day. Dampness of the underclothing from perspiration favors the growth and development of disease germs and skin parasites, so that clothes should

either be changed when wet or well aired and dried when they are removed.

Regarding the color of outer clothes, black or dark shades absorb the heat rays of the sun much more than white fabrics or those approaching white in hue. For this reason white clothes are worn in the tropics and in hot weather.

The amount of clothing does necessarily depend on the temperature, although heavy underclothing may be needed for those living out of doors in cold weather. Those spending much of their time indoors who have become accustomed to clothe themselves properly find that they have grown far more independent of changing weather conditions. They do not suffer greatly from extremes of heat or cold. In our artificially-heated houses, where there is practically a summer temperature during winter, it is unwise to wear heavy clothing; many people acquire colds by doing so. It is better to dress as in summer while in the house, but very warmly with ulsters, furs, etc., before going into the cold.

Impervious materials, as rubber, leather and mackintosh are, of course, unfit for clothing except as a protection against wind and wet.

Foot- and Head-gear.—Hats should not fit, but shoes should. The tight hats generally worn by men check the circulation of blood in the scalp; but shoes to fit should be made to order from an outline drawn of the stockinged feet. Shoes should be nearly an inch longer than the foot; the toe should be neither pointed nor absolutely square, and the sole should be nearly flat on the bottom. Extension of the soles outward around the uppers affords better support for the foot. Tight shoes with extremely high heels deform the feet and interfere with their health. In all except cold weather, low shoes are preferable to high shoes.

Sanitation of the Body.—Constipation.—In these days everybody believes in sanitation of the community. Pure food, pure water, efficient sewage, clean streets are desired by all intelligent persons. The menace to the individual, however, from unsanitary conditions in the community is far less than the menace from unsanitary conditions in his own body. A clean skin does not necessarily mean a clean body. The lining of the food canal and of the intestines is nothing more than a continuation of the skin.

Under the artificial conditions of living, which civilization demands, this internal skin, as it were, is not always as physiologically clean as it should be. The sewage wastes of the body are not always efficiently released. This condition of stagnation or sluggish movement in the self-cleaning functions of the body, which is called *constipation,* is so common that it is often accepted as an inseparable feature of so-called civilized existence. But it can be prevented to a great extent by proper attention to personal hygiene. Constipation is not only an important factor in reducing the general level of health, but it is, in itself, often an index of lowered bodily condition.

The causes of constipation are manifold, but may here be grouped

under the general cause of improper habits of living. Heredity plays some part, but the average individual, with good heredity, develops constipation because of the artificial conditions of his life. Lack of exercise, faulty diet, and neglect of the bowel function, are the prominent causes. Another important cause of constipation is the constant use of laxatives and purgatives. Many purgatives, even those commonly considered harmless, such as laxative salts and mineral waters, are often distinctly harmful, causing a chronic inflammatory condition of the bowel or aggravating the already existing inflammation that is present. The chief error in diet that induces constipation is the use of concentrated food. Such food leaves little residue or waste to stimulate the bowel movement. The intestinal contents become dangerous by being long retained, as putrefying fecal matter contains poisons which are harmful to the body. Abnormal condition of the intestines are largely responsible for the common headache and for general lowered resistance, resulting in colds and even more serious ailments. Constipation is extremely prevalent, partly because the diet of most people usually lacks bulk or other needed constituents, but partly because they fail to eliminate regularly, thoroughly and frequently.

Free water drinking when the stomach is empty, especially before breakfast, is beneficial in constipation. Free water drinking at meals, on the other hand, may prove constipating. Excess of water should be avoided by the very feeble or those suffering from heart disease or dropsy. Six or eight glasses of water a day is the normal amount.

The best regulators of the bowels are foods. Foods should possess sufficient bulk to promote the action of the intestines and should contain a due amount of laxative elements. Foods which are especially laxative are prunes, figs, most fruits except bananas, fruit juices, all fresh vegetables, especially green of all sorts, wheat bran, and the whole-grain cereals. Foods with the opposite tendency are rice, boiled milk, fine wheat flour in bread, cornstarch, white of egg.

The use of wheat bran in cereals, in bread and even in vegetables is a prevention of constipation, as is also the use of agar-agar. This is not digested and absorbed, but acts as a water carrier and a sweep to the intestinal tract. It should be taken without admixture with laxative drugs. Paraffin oil is especially good as an intestinal lubricant to assist the food to slip through the intestinal canal at the proper rate of progress, provided the oil is first freed, by long shaking with water, from certain impurities. Taken several times a day, oil may retard secretion of gastric juice and also interfere with absorption of food.

In general cathartics should be avoided, since certain drugs are often harmful, when their use is long continued, and the longer they are used the more dependent on them the user becomes. The occasional, but not habitual, use of an enema with warm water (followed always by a second enema of cool water to prevent relaxation) is a temporary expedient.

Massage of the abdomen, deep and thorough, with a sweeping movement of the fingers on the left side of the abdomen from above downward, also promotes the process of defecation.

The normal man and woman should find no difficulty in having complete movements regularly two or three times a day by merely living a reasonable life, being careful especially to avoid overfatigue, to take regular exercise, including in particular, deep breathing exercises, and to maintain an erect carriage.

The natural instinct to defecate, like many other natural instincts, is usually deadened by failure to exercise it. Civilized life makes it inconvenient to follow this instinct promptly. The impulse, if neglected even five minutes may disappear. There are few health measures more simple and effective than restoring the normal sensitiveness of this important instinct. It may require a few weeks of special care, during which cold water enemas at night, following evacuation by paraffin oil injection, may be needed, until the normal two or more evacuations a day are reëstablished.

Posture.—One of the simplest and most effective methods of personal hygiene to avoid self-poisoning is by maintaining an erect posture. In an erect posture the abdominal muscles tend to remain taut and to afford proper support to the abdomen, including the great splanchnic circulation of large bloodvessels. In a habitual slouching position the blood of the abdomen tends to stagnate in the liver and the splanchnic circulation, causing a feeling of despondency and mental confusion, headache, coldness of the hands and feet, and chronic fatigue or neurasthenia and often constipation. A slouching attitude is frequently the result of disease or lack of vitality; but it is also a cause.

Many persons who have suffered for years from the above-named symptoms have been relieved of them after a few weeks of correct posture, sometimes reinforced by the artificial pressure of an abdominal support and by special exercises to strengthen the abdominal muscles.

In walking, the most common error is to slump, with the shoulders rounded, the stomach thrust out, the head thrown forward, chin up, and the arms hanging in front of the body. It is characteristic of these with weak muscular and nervous systems. To set the shoulders back and square them evenly, to keep the chest high and well arched forward, the stomach in and the neck perpendicular like a column, and the chin in, are simple fundamental measures that most persons know and many disregard.

But it is not enough to have an erect carriage and a well-poised head; one should also have well-directed feet. Weak feet, and its final stage flat feet, are more common among women than they are among men, because it is not a purely local condition in the arch of the foot, as many suppose, but primarily due to a general weakened condition of the leg muscles that support the arch. The more vigorous exercise of boys as compared with that of girls probably protects them in some degree from this trouble.

Weak feet are gradually converted into flat feet by faulty standing and walking posture and lack of leg exercise. Toeing out, whether walking or standing, so commonly noted among girls and women, places a great strain upon the arches of the foot. The correction of this fault by persistent toeing in, Indian fashion, and daily exercise of the leg muscles (rising on the toes twenty to thirty times night and morning) will do much to prevent flat feet.

Not only in standing, but in sitting, erect posture has been found to be a much more important factor in the maintenance of good health than is generally supposed. In sitting at a desk or table, when reading or working, the common fault is to adopt a sprawling attitude, with the shoulders hunched up, the elbows stretched forward, the body too far away from the desk or table and the weight resting on the buttocks. Very often the desk or table is too high, and the arms cannot rest easily upon it, thus causing a certain strain on the structures around the shoulder-joints.

To correct this fault, let the person use if possible a chair with a back curved forward and sit well back in the chair, but close to the desk, so that the fleshy inner part of the forearms may rest easily upon its surface without pushing up the shoulders. The arms should hang easily from the shoulders and the elbows should not rest upon the table. The shoulders should be evenly square, as in the correct standing posture. In right-handed persons the light should fall over the left shoulder or directly from above. The body should rest upon the full length of the thighs, not solely on the buttocks, and the feet (not legs) be crossed and resting lightly on the ground on their outer edges. In other words, the position should be freed from strain, especially strain of special groups of muscles.

Pains, falsely ascribed to rheumatism, writer's cramp and many other needless troubles are often caused by faulty posture in working or reading.

In children faulty posture may mar the future of the individual by causing spinal curvature and physical deformities that interfere with physical and mental efficiency throughout life, and often lowers the resistance to disease. Deep breathing through the nose and "setting up" exercises are of great value in such cases.

The teaching of proper standing, proper walking and proper sitting should be a part of all school discipline as it is at military schools, especially as there is the temptation to crouch over the school desk—which is usually the source of the first deviation from natural posture.

Care of Mouth, Teeth and Gums.—There are two forms of mouth danger—dental caries or decay, which is at first largely a chemical process and affects the tooth proper, and pyorrhea or Rigg's disease, which affects the tissues surrounding the root of the tooth, and is accompanied with infection by pus bacteria and possibly also by animal parasites, termed *entameba*. Scrupulous cleanliness of the mouth largely prevents both of these maladies.

In caries, or dental decay, plaques or films of mucin from the saliva

form on the tooth surfaces and enclose bacteria and particles of carbohydrate food, which undergo fermentation with the formation of lactic acid. This dissolves the lime salts on the surface of the teeth, leaving only the organic matter, which is then attacked by bacteria. Putrefaction sets in, and a cavity is formed. This cavity is a menace to health, as it harbors various forms of bacteria, which infect the general system through the root canals, or the digestive system by being swallowed with the food. It may also give rise to abscesses at the root tips.

Pyorrhea is an infection of the gums or tooth sockets. It begins beneath the edges of the gums that have been injured and especially when there has been an accumulation of tartar or lime deposits. As the infection progresses and destroys the membranes that attach the root of the tooth to the socket, a pocket is formed around the root and the tooth becomes loosened. This disease is said to be responsible for far more loss of teeth than decay.

But the evil does not step here. In the pocket pus is continually being formed and discharged into the mouth and swallowed. Also the teeth rise and fall in their diseased sockets in chewing, bacteria are forced into circulation and may be carried to distant parts, where they work harm.

It was formerly supposed that the ill effects from such conditions as dental decay, abscess and other pus foci were wholly due to toxins or poisons thrown off in the blood stream by bacteria at the focus. It is now known, however, that the bacteria migrate into outside tissues through the blood and lymph streams. In joint affection, they clog and obstruct the small bloodvessels, interfering with the nutrition of the joint tissue, causing deformity and enlargement, as in arthritis deformans, as well as in acute inflammation, such as rheumatic fever. Indeed, this condition of subinfection or focal infection is becoming recognized as a far more important cause of disease than the so-called "auto-intoxication." At any rate it is a sufficient cause of disease to justify a vigorous campaign for the better care of the teeth and for a thorough search for mouth-infection in every case of obscure disease.

Gum infection is not always due to conscious neglect. Some people do not know how to properly cleanse the teeth. Others have tissues of low resistance and need to give extra care to tooth and gum cleansing under the closest dental supervision. Others, again, have spent large sums for dental work that filled the mouth with crowns and bridges difficult to keep aseptic or surgically clean. There are various means which can be used to prevent or cure these dental evils.

First, the importance of general hygiene, in order that a general resistance to mouth infection may be built up, cannot be overestimated. The cultivation of normal eating habits with respect to the vigorous use of the jaws by thorough mastication, the eating of hard, resistant, crusty foods every day is the next desirable means of tooth and gum hygiene.

The teeth, gums and tongue should be cleaned night and morning and after each meal, if possible, by rapid rotary brushing. Strong pressure is not advisable. Rapidity of movement is the important point. This stimulates the circulation and increases the resistance of the gums and cleanses the teeth at the margins from the accumulations of tartar which being at first soft are easily removed by a brush. A brush should be used with bristles that are stiff and of different lengths, so that the innermost crevices of the teeth may be reached. If the gums are sensitive a moderately stiff brush can be used until the gums can bear the more vigorous treatment. The tongue should also be carefully cleansed with the tooth brush. Tooth powders and pastes may be used, but should not be the main reliance. Some powders, if used too freely, are liable to unduly thin the enamel of the teeth. The use of dental floss silk between the teeth, provided care is taken not to press it against the gums, is also helpful.

A number of investigators have reported the presence of an animal parasite—*Entameba buccalis*—in all cases of pyorrhea, and it is thought that this parasite may be one of the causative factors in this disease. Emetin, the active principle of ipecac, which has been successfully used in the vegetative stage of amebic dysentery, has been proposed for the treatment of this trouble. Such a remedy should only be used, if at all, in connection with thorough surgical treatment and dental prophylaxis. It is claimed that in the early stages of pyorrhea a mouth wash composed of 2 drops of fluidextract of ipecac to a half-glass of water is very serviceable. As at that stage a mouth wash is entirely harmless, it may be tried, especially as it is now thought that some degree of pyorrhea or entamebic infection is almost always present.

For an alkaline wash, there is nothing better than lime-water, made from coarse unslaked lime; alkaline washes, however, are very superficial in their action, while fruit acids coagulate and thus render removable the mucin plaques and prevent the formation of tartar. They also cleanse the tongue and membranes of the mouth generally, which may be important sources of infection. These acids are found in grape-juice, orange-juice, lime- or lemon-juice, apple, etc. Such mechanical cleansing is particularly important before retiring, as it is usually during the night that the most damage is done. But the condition of the teeth must be determined, especially as to whether there is any erosion or destruction of enamel, before either alkaline or acid washes are used exclusively. Periodic examinations and cleansings by the dentist are the only safe measures.

Until lately too much attention has been given in this country to the saving of the teeth, without fully realizing the dangers of infection from the mechanical devices employed. The teeth should not be extracted on mere suspicion and without proper effort to save them, but it is far more important to save a person from some remote infection than it is to save his tooth, not that all crown and bridge work is improper, but such work should be of a character only that will admit of surgical cleanliness in the mouth. Moreover, teeth so treated should always

be examined by *x*-ray, when there is evidence of systemic disease, in order to be sure that the roots and sockets are not infected.

In early life the jaws should be carefully examined to determine whether or not the proper development is taking place. If the upper and lower teeth fail to articulate, extra strain is placed upon certain teeth and the sockets are liable to injury and infection. Faulty development can often be corrected and deformities that interfere with mastication can then be avoided.

The temporary teeth should not be allowed to be removed by decay. Thorough dental and personal care should prevent this. If cavities form, they should be filled under proper precautions and the teeth should be saved as long as possible, unless they are causing infection.

Care of the Eyes.—Defective vision may be a cause or a sign of ill health. Therefore when there is trouble with the eyes an oculist should be consulted. But there are several things which a person may be taught to do to care for his own eyes. The eye, like other organs, has its factor of safety; that is, it will stand considerable abuse and it is protected from injury in many ways, but if the eyes are very much overstrained they suffer seriously.

The common eye defects such as astigmatism, myopia and hypermetropia can usually be corrected by glasses. The defect having been found and glasses fitted, the condition of the eyes should be checked up every year or two, as in some people frequent changes of glasses are necessary because of changing conditions with advancing years. Even after proper glasses have been fitted, eye strain may be brought about by the overuse or improper use of the eyes. Persons whose eyes are easily fatigued should be told not to use them continuously, but to give them occasional rest. Eyes that are free from disease and optically perfect may be overstrained by too much use, and simple rest will relieve this condition also as well as such accompanying symptoms as headache and nervousness. Many people suffer seriously from eye-strain as the result of too frequent attendance at moving-picture shows. Headache, nervousness and inflammation of the eye-lids on the day following are not unusual and should be a warning to take more care of the eyes.

Among the number of faulty reading or working habits that produce eye-strain are the following:

Insufficient Illumination.—Reading or working in a dim or flickering light especially at the close of day when twilight is coming on.

Excessive Illumination.—Reading or working in the direct glare of the sun or by close, direct electric or lamp light.

Faulty Posture in Reading or Working.—Facing the light or having the back to the light, or the light directed over the right shoulder when writing or working. Reading in a cramped position or when lying down. Reading on trains or when walking.

A very common error is the use of a brilliant desk light. The best light is an indirect diffused light of sufficient strength to make the letters on the page stand out black and clear and of uniform distinctness.

Exposure to excessively brilliant light will sometimes bring on inflammation of the eyes, or even temporary blindness, as in snow-blindness. At the seashore and on the water, or in the winter time when traveling over the snow, amber glasses will add to the comfort and prevent eye-strain. If a person works facing a window, it is advisable to wear an eye-shade, otherwise there is a struggle between the tendency of the bright light to close the pupil and the tendency of the work required to keep it open.

The reflex evils from eye-strain are great and numerous and are often incorrectly ascribed to entirely different causes. Headache, nausea and dizziness are especially frequent results of eye-strain. Some of the breakdowns in middle life may be due primarily to the reflex effect of eye-strain.

Eye-strain is to be prevented by scientifically adopted spectacles, by care to secure the right kind of illumination, and in some cases by systematically resting the eyes.

Exercises with Rest.—By exercise in general is meant muscular exercise. To offset the evils of a sedentary life, it is advisable to spend one hour daily, or at least fifteen minutes, in some kind of vigorous muscular exercise.

The sewing-machine is probably the most beneficial form of medicinal home exercise that is likely to be followed faithfully. Simple stretching in bed when a person wakes up is helpful, especially if combined with breathing exercises.

The most beneficial exercise, as a rule, is that which stimulates the heart and lungs, such as running, rapid walking, hill climbing and swimming. These should, of course, be graduated in intensity with varying age and different degrees of activity.

Gentle muscular exercise after meals promotes normal digestion and should be practised for a quarter of an hour after each meal, but violent exercises immediately after meals should be avoided as a large amount of blood is thus engaged by the digestive system.

A very important fact to be impressed upon the average man is to take into consideration that, whereas he naturally gets some outdoor exercise in summer, he is apt to allow it to lapse in the winter. Such a decided change in the amount of exercise is dangerous and should be guarded against by taking regular gymnasium exercise.

Systematic exercise is important and beneficial, even when the individual finds it uninteresting. But, although exercise when self-imposed is wholesome, exercise to which one is naturally attracted is more so. Golf, horseback riding, tennis usually inspires enthusiasm, and enthusiasm itself is healthful. Walking may also do so if the walk has an object, as in mountain climbing, rowing, polo-playing and other sports.

There is considerable evidence that college athletics often seriously injure those who engage in them, although they were originally encouraged for the precisely opposite effect. The value of exercise consists not in developing large muscles nor in accomplishing athletic feats,

but in obtaining physical poise, symmetry of form, and the harmonious adjustment of the various parts of the body, as well as in furthering the proper activity of cell tissues and organs and the elimination of waste products.

Even those whose work is largely muscular, unless it involves most of the muscular system, may do well to exercise the unused muscles. It is distinctly unhealthful either to overdo or underdo work, rest or exercise. Not all persons are in need of exercise, nor are all in need of rest; but almost everyone needs to change the proportion between the two. Today many people are suffering from too much or too little work.

Useful, purposeful work not only inspires interest and enthusiasm, but it is necessary for a normal healthy life. Work when done with zest is an invigorating tonic. Exertion of any kind is usually agreeable at first, and becomes drudgery only when too much protracted.

Methods of preventing or correcting overstrain vary greatly, according to the kinds of overstrain. In general, overstrain of any kind tends to fatigue and is therefore to be avoided. A very moderate degree of fatigue is perhaps normal, but anything approaching exhaustion should be forbidden.

Working hours should be so arranged as to enable the worker to fully recover over night, partly from sleep and partly from the recreation enjoyed in leisure between work and sleep.

Variety of work is especially needed at the present time, when specialization tends to lead men to extremes. Changes in work which present a sense of monotony will greatly increase the power to work.

Not only the functions of the body but those of the mind require exercise—exercise in thinking, feeling and willing. The exercise of the will is of first importance. The will is exercised every time a decision is made. One of the advantages of all games is that they require decision by the players.

Since the work of most people is likely to produce some unhygienic element which cannot be avoided, a compensation should be sought in an avocation or "hobby" to be practised out of regular working hours; and the avocation should be far removed from the nature of the regular work. But play itself should not be turned into work. Recreations should be enjoyed for their own sake, or else they are not recreating.

Play is a half-way stage between work and rest. In a hygienic life there must be a certain amount of actual rest. Every bodily power requires rest after exertion. The muscles require relaxation after every contraction. The man who is always tense in muscle and nerve is wearing himself out.

The power to relax when fatigue requires it is one of the most important safeguards to health. Lying down when tired is a good rule for hard working people. Idle and lazy people rest too much. Relaxation is only a short vacation, as it were, between two activities,

Bathing and swimming supply in their numerous forms examples of both healthful activity and relaxation. A cold sponge or shower, alternated with hot, affords excellent gymnastics for the skin. A very hot bath lasting only a minute, or even a hot footbath is restful in cases of fatigue; but the neutral or tepid bath is the most restful of all.

The nervous relaxation induced by neutral baths is an excellent substitute for sleep in cases of insomnia, and often it induces sleep as well. Neutral baths are now used not only in cases of insomnia, but also in cases of acute mania.

Sleep may also be induced by monotonous sound or lack of sound, or the monofonous holding of the attention. Keeping awake is due to continued change or interruption or arrest of the attention.

Exercise taken in the afternoon will often promote sleep at night to those who find sleep difficult. Slow, deep, rhythmic breathing is useful when a person is wakeful, partly as a substitute for sleep and partly as an inducer of sleep.

Sleep being Nature's great restorer should be enjoyed to the full. Sleep should not only be sufficient in duration but also intensity and regularity. The number of hours of sleep generally needed varies with circumstances; the average is seven to nine. Generally a person should sleep when sleepy and not try to sleep any more. Growing children require more sleep than adults, and women, as a rule, more than men.

The best sleep is with the stomach empty. Food may put one to sleep at first by directing blood from the head; but it disturbs sleep later. As already pointed out, sleeping out-of-doors is more restful than sleeping indoors.

The character of sleep depends largely on the mental attitude of the person on going to bed. The habit should be cultivated of dropping work and cares at bedtime and thinking only of pleasant things. If worries are taken to bed the sleep cannot be restful.

Serenity and Poise.—If a person is to be really healthy his mental attitude must be healthy. A healthy mental attitude implies many elements, but they may be all summed up in the word "serenity." Probably no other one hygienic requirement is of greater importance than this. Moreover, the attitude of "healthy-mindedness" should be encouraged not only in order to produce health, but as an end in itself, for which, in fact, even health itself is sought. In short, the health of the body and the health of the mind act and react on each other.

Serenity may generally be kept through following the other measures already described. Discontent is undoubtedly very often the consequence of wrong conditions in the body, and through melancholy, worry, peevishness, fear, is apt to appear as arising from outward conditions, but there are usually real physical sources, existing within the body itself. A person who is physically ill is likely to be ill-satisfied with everything and without suspecting the fundamental cause of

the discontent. When the oppressive "cause" is removed, the discontent remains none the less, and is attributed to something else.

Among physical conditions which are often accompanied by mental depression and fatigue are the near approach to the menstrual period in women, constipation, eye-strain, or the effects of alcohol or other drugs, a sedentary life, a bad posture or weak abdominal muscles—all of which may be corrected by the proper observance of personal hygiene.

There is, however, a danger to which some people are especially subject—the danger of paying too much attention to physical hygiene. Such a person becomes fearful lest he is not doing exactly the right thing. He looks suspiciously at every article of food and fears that it will disagree. He fears that he has strained his heart; he worries over the loss of an hour's sleep; he chafes because he has not got his vacation at the right time or of the right length. The hypochondriac thus neutralizes practically all the benefit of the hygienic measures by disregarding this special measure of keeping serene.

On this theory the devotees of mind-cure cults have derided every hygienic measure but their own. But it is a great mistake to stake everything on the simple resource of mental equanimity. In some cases it is criminal, as for instance to neglect surgery for cancer, or antitoxin for diphtheria, or outdoor living for tuberculosis, though in its proper place "mind-cure" is an essential part of personal hygiene. In order to get the benefit of other rules, there must be no worrying or watching of symptoms.

Incessant worry, even if mild, is more exhausting than occasional fits of anger or fright or overexcitement. If unceasing, worry will often drain away the largest store of nervous energy. Worry, as it were, short-circuits nerve currents in the brain, which normally form long circuits through the body.

Each must, of course, learn for himself how to avoid anger, fear, worry, excitement, hate, envy, jealousy, grief and all depressing or abnormal mental states. To do so is an art to be practised. But much can be done by instruction.

Most people are inclined to live too many days in one, which tends to disturb their serenity. When this condition becomes inseparable, it can often be changed by "living one day at a time." Almost everyone has it in his or her power, for merely one day or at any rate one hour, or one minute, to eliminate fear, worry, anger or other unwholesome and disturbing conditions; and this should be cultivated and encouraged.

Modern life in this country has been gradually speeded up to the breaking point and many people are suffering from a constant oppressive sense of hurry—they have "so much to do" that they cannot do it, and this fact urges them on in the vain endeavor to catch up. They must be brought to realize that the sense of hurry actually reduces the effective speed of work—in other words, that "the more haste, the less speed."

Professor William James commends as an aid to mental hygiene the adoption of a "religion of healthy-mindedness," in which all wrong or diseased mental states are removed, and only the healthy ones, such as courage, patience, optimism and reverence are cultivated.

When the mind turns from shadow to sunlight, the body will tend also to assume the radiance of health. There is no duty so much underrated as the duty of being happy. The habit of being happy enables one to be freed, or largely freed, from the domination of outward conditions. Though this trait is apparently totally lacking in some, while existing in others to a high degree, experience has shown that it can be cultivated.

The secret of equanimity consists not so much in repressing fear or worry as in dropping or ignoring it, that is, directing and controlling the attention. This is the main art of mental hygiene, and it is a very important, though much neglected, branch of personal hygiene.

CHAPTER XXI.

MILITARY HYGIENE.

By C. W. BERRY, M.D.

Military hygiene is a term used when the principles of hygiene are applied to bodies of troops and their environment.

These principles are not new to the student of preventive medicine, but situations are presented which make their application difficult, and in many cases the only choice in a difficult problem is the lesser of two evils.

At first thought it would appear that in a military body where the men are all selected specimens, and an order of any kind is immediately obeyed, that all difficulties as to the enforcement of recognized sanitary laws had been removed, and a camp or post where soldiers are quartered should be an example to the outside world of the soundness of hygienic teachings. The stumbling block to this lies in the fact that military bodies are created primarily for war, and hygienic principles have to take second place to military necessity. A commander of troops can seldom consider the health conditions of a location to which his troops may move, the military advantages of the terrain being the more important for the time being, and more often he has no choice as to the site on which he must meet the enemy.

Another factor to be considered is that large bodies of men are obliged to live for long periods of time in close contact with each other, thus greatly increasing the probability of disseminating any chance infection. Experience has taught us that communicable diseases are very apt to appear or spread rapidly in a military camp in spite of the precautions that are taken to avoid them.

In the study of military hygiene it is well to commence where an army begins, namely with the recruit, and then follow him throughout the different phases of the service he may encounter. In this way a good working knowledge of the problems and difficulties that confront the hygienist in military life may be acquired, and also some of the means used at the present time to preserve the health of our armies, and to keep them in such condition as to render the greatest service. The problem of the doctor in the army is not only to keep his command well, but to return to duty as quickly as possible all men incapacitated either by illness or wounds, so that his list of non-effectives may be kept as small as possible.

THE RECRUIT.

Men who desire to enter the military service must meet certain requirements as to height, weight and physical condition, and broadly

speaking, less than 50 per cent. of those applying are accepted for enlistment in times of peace.

The following standards were in effect before the War with Germany:

Age.—Eighteen to forty-five years.

Height.—From a minimum of 64 inches to practically no limit, provided the candidate is properly proportioned as to weight, chest measurements, etc. For some branches of the service as the Cavalry or Field Artillery, the maximum is 70 inches.

Weight.—The rule is two pounds of weight for every inch in height and five additional pounds for every inch above 67 inches.

Chest Measurement.—Between 64 and 67 inches in height the mean of the chest circumference should be 33 inches, or about half of the height, with a mobility of two inches. The minimum at expiration is 32 inches.

It is permissible to enlist by special authority men with special qualifications who may deviate slightly from the above figures.

The physical examination as outlined in General Order 66 (War Department) is a rigid one, and embraces tests of the vision and hearing, and a thorough examination of the entire body, and the normal working of its different functions.

In time of war when troops are urgently needed, the standards are often lowered, and men accepted who under peace conditions would be rejected. War Department Bulletin 133, of July 14, 1917, reduced the minimum height to 61 inches and weight to 110 pounds.

The reduction of accepted standards for recruits is sometimes followed by disastrous results, the recruits thus obtained being unable to stand the rigid training and severe hardships of a campaign, and actually impede progress by crowding the sick report of their organization, and later the pension roll of the nation.

The life of a soldier during times of intensive training in preparation for battle is not an easy one. His time when in mobilization camp is fully occupied with more or less strenuous work, to which may be added long marches or hikes, each man carrying forty to sixty pounds, digging trenches and ditches, cutting up trees for fire wood, exposure to all kinds of weather, irregular meals, poor cooking and often a night in the open with no shelter or protection from the elements.

An ordinary day's work in camp is shown by the following schedule:

First call, 6 A.M.
Assembly, 6.15 A.M.
Mess, 6.35 A.M.
Sick call, 6.55 A.M.
Fatigue, 7A.M.
Drill, 7.30 to 11.30 A.M.
Mess, 12.
Drill, 1 P.M. to 5 P.M.
Retreat, 5.40 P.M.
Mess, 6 P.M.
Taps, 11 P.M.

The eight hours given to drill are fully occupied, the men being on their feet and undergoing active physical exertion, other camp duties being outside of these hours.

During actual service at the front in time of war, all hardships are greatly increased, and it is often necessary to push troops to the limit of human endurance that positions may be held or taken.

The class of recruits obtained is a factor in military hygiene. Men from country districts are usually better specimens of physical manhood but, on the other hand, on account of their isolated manner of living have not developed immunity from the common communicable diseases. It is among these men that epidemics of mumps, measles, scarlatina, epidemic meningitis, etc., break out, and spread with special virulence.

Men from cities are usually of the mechanic class and make good soldiers, although their habits are at times objectionable. Men between the years of eighteen and twenty-five are most amenable to discipline and military training, those of more mature years are usually set in their habits and hard to break into the rigid regime of a well trained army unless they have had previous military training.

Men over forty-five years of age as a class are not able to endure the hardships of a rigorous campaign, and as a rule do not accompany first line troops.

It is essential that recruits be of good character, and of average mentality, those whose habits will not bear scrutiny are a menace in the army, their example being readily followed by the more susceptible and younger men.

Regarding those of low grade mentality who now and then slip by the examining physician, the best that can be said is that the sooner they are eliminated the better; they are the despair of the drill instructor, are continually in the guard house for breaches of discipline and are a nuisance to the entire organization, the actual cause of deficiencies rarely being recognized outside of the medical department.

In this connection, it might be well to point out a class of men of unstable nervous organization, who, after a few months of army life, break down mentally or become neurasthenics. Sometimes an attempt is made to simulate insanity so that punishment of delinquencies may be averted, or release from military service obtained. Much may be done by company commanders to prevent nervous disorders by a judicious use of games, athletic sports, etc., and seeing personally that all of their commands take part and are interested in the different diversions. Men must not be allowed to mope around their tents avoiding their fellow soldiers; good healthy companionships are to be encouraged, and the contrary broken up.

Having thus obtained a fair specimen of manhood as a recruit for the service, the next step will be to furnish him with the regulation clothing and equipment, and train him in the duties of a soldier.

CLOTHING.

The clothing of a soldier must fill certain requirements, both military and hygienic.

Military fashion insists on a certain smartness and ornamentation, a distinctive color and fit that makes the wearer take pride in his profession. Since modern warfare made the wearing of bright colors and ornaments dangerous on the battle-field, two uniforms are now issued, namely, the olive drab service uniform of a brown hue, which matches well with the landscape and makes the wearer invisible at medium distances, and the full dress uniform of blue, with various trimmings according to the arms of the service.

Hygiene on the other hand demands that the head gear shall protect from the tropical sun in the summer, and also protect the head, ears and neck during service in cold climates. The other clothing of cotton or wool must be such that the wearer can do hard work without being hampered by his clothing which must be loose fitting and yet preserve that military smartness which is part of the profession of the soldier. The shoes especially need care in selection, and are treated of more fully in the section on troop movements.

All of these requirements cannot be met by any one uniform, and the problem has been disposed of by the issue of different articles according to the service to be performed, for instance, the man going on duty in our Philippine possessions would need a different outfit from the soldier going to a post in northern Alaska.

From a hygienic standpoint, the full dress equipment is not desirable, the tight fitting blouse with upright tight collar, which compresses the neck, is uncomfortable to say the least, and comfort has in many cases been sacrificed for military smartness, still as these uniforms are worn for short periods of time only, their effects on the health of the organization can be ignored.

The service uniform either of cotton or wool with flannel shirt, service hat (Montana peak), canvas leggings, and well-fitting shoes on the other hand admirably fit the need of the American soldier and give him the maximum protection from heat and cold, without impeding his movements.

For protection against rain, the poncho or slicker is issued which, when correctly worn, offers much protection from inclement weather, and in addition is used to put under the bedsack to keep off the dampness of the soil when sleeping on the ground. The so-called overseas cap, issued to the American troops in Europe during the War with Germany, was a good example of what a head covering ought not to be, as it afforded no protection for the face and eyes from the storms, or the rays of the sun.

The recruit when enlisted draws the following articles from his supply officer:

1 bedsack (an empty tick which is filled with straw and used for a bed).

2 olive drab wool blankets.
2 pairs of breeches (cotton and wool).
1 waist belt.
1 service hat and cord.
1 pair of canvas leggings.
2 pairs of shoes.
4 pairs of stockings.
3 pairs of drawers.
3 undershirts.
1 identification tag.
1 overcoat.
1 shelter half.
1 poncho.
2 flannel shirts.
Toilet articles.

The hygienist is principally interested in two problems in connection with the clothing of a soldier, the first being to see that he actually gets the clothing allowed, the second to see that it is worn properly and kept clean.

Often an organization will be unable to draw needed articles of clothing for a long time on account of shortage, or other causes of delay, and this may be an actual cause of suffering among the men, as for instance, only being provided with summer clothes and being suddenly shifted to a cold climate without proper equipment. When such an event occurs, shift must be made by local purchase and apportioning the heavy clothing possessed among the men until suitable equipment can be provided. Precautions must also be taken against increased chances of infection by common colds and respiratory infection due to exposure.

The men's quarters can be made as comfortable as possible, plenty of straw provided for warm beds, and outdoor work reduced to a minimum and performed during the warm parts of the day. Any overcoats in the command can be distributed among those on guard or whose duties require them to be exposed for long periods of time. Active exercise is a good way to keep warm if the men do not have to stand around afterward without protection. In camp, where little or no shelter is available, large camp fires around which the men can gather are a help.

Regular inspections of the soldier's person and equipment are provided for in Army Regulations, and are a means of keeping a check on the cleanliness of the individual soldier. Inspection should go further than merely looking over the clothing and material spread out for observation. Soldiers have been known to wear the same underwear for weeks, keeping one or two sets scrupulously clean, ready for inspection at any time, but never wearing them. Others will go without the undershirt or drawers or even socks as causing too much bother. Many do not take time to undress at night, but turn in and get up ready dressed, sometimes even to shoes, unless properly watched.

These habits are the kind which promote the breeding of pediculi, and sometimes cause the infection of all in the command, especially when the bathing facilities are limited. During cold weather, unless special care is taken, such customs become general.

During actual service at the front, as when a regiment is occupying a place in the fighting line, little or no attention can be given to personal hygiene, and it is not unusual for men to go two or three weeks without a chance to change their clothing or clean up in any way. It was found in the War with Germany, that a unit that had served any length of time in the front lines, was always badly infected with body lice on its return to a rest camp, and one of the duties of the medical staff was to take care of the so-called de-lousing process at that time.

By instilling proper habits in these matters, the medical officers can do much along the lines of preventive medicine.

"The excellence of an organization is judged by its field efficiency." I. D. R.

EXERCISES.

The underlying principle in the training of a soldier is to increase the probability of success in battle. This implies that a high grade of physical efficiency and endurance is to be reached and maintained by each individual. To effect this, systematic exercises are planned and executed in the form of drills, setting up and athletic exercises, marches, use of weapons, etc. These are commenced gradually and increased to a maximum as rapidly as the recruit is able to stand the work.

The following schedule is given as an example of the work outlined for the men in one of our training camps during the War with Germany.

The time devoted to training each week was forty hours, leaving Wednesday and Saturday afternoons free for recreation, and for additional drill and instruction for backward men. Instruction courses were also given in the evenings to the officers as a preparation for the following day's work. The work was divided as follows:

First week, instruction twenty hours, athletic work and drill twenty hours.

Second week, instruction twelve hours, athletic work and drill, twenty-eight hours.

Third week, instruction sixteen hours, athletic work and drill twenty-four hours.

Fourth week, instruction sixteen hours, athletic work and drill twenty-four hours.

The athletic work consisted of foot ball scrimmages, wrestling, tug-of-war, jumping, hurdling and running over rough country.

The efficient preparation and serving of proper food is no small factor in reaching a high state of physical efficiency, and to keep a command in good condition requires constant supervision of bowel and digestive functions by the medical officers.

Perhaps the most important part of the training of a recruit is the acquirement of a subconscious habit of obedience and subordination to those in authority which is called military discipline.

The very first paragraph in the Army Regulations reads "All persons in the military service are required to obey strictly and to execute promptly the lawful orders of their superiors." To quote from the Manual for Non-Commissioned Officers, "Obedience is the first and last duty of a soldier. It is the foundation upon which all military efficiency is built, without it an army becomes a mob, while with it a mob ceases to be a mob and becomes possessed of much of the power of an organized force."

The point for the hygienist to observe in this training is the fact that the soldier can also be handled so that he has the same subconscious obedience to hygienic principles as he observes toward other military subjects. The well instructed man covers his excreta at the latrine as a matter of course, and not because a sentry is stationed there to make him do it; he also washes his hands before eating, keeps his food protected from flies, and avoids ice cold drinks, slops, trash, etc., when on the hike.

It is the poorly trained man who causes the most trouble for the regimental surgeon.

This thorough training of the soldier in the principles of hygiene, is of the greatest importance to the medical officer, who is responsible for the health of the organization to which he is attached, and is worth all the time he may spend to attain it.

MOVEMENT OF TROOPS.

Soldiers generally depend on marching especially during a campaign when it is necessary to move a command from one point to another. When long distances are to be covered, and transportation is available, railroads or boats are employed. "Marching constitutes the principal occupation of troops in campaign, and is one of the heaviest causes of loss. This loss may be materially reduced by proper training, and the proper conduct of the march." I. D. R.

Proper training consists in gradual hardening of the men and the thorough instillation of marching discipline.

Special attention should be paid to the fitting of shoes and the care of the feet. Regulations now provide that each man must be fitted with shoes in the presence of an officer, who is held responsible that the man is properly provided with suitable foot gear.

The shoes should be of regulation army pattern, and of sufficient size to allow the foot to spread while carrying weight of equipment on long marches (hikes). The feet, as a result of unaccustomed use, badly fitting shoes or socks, or through neglect, are liable to various injuries of which blisters, abrasions, bruises, sprains and corns are examples. These should all receive prompt attention, as a footsore army is of little use. During the recent campaign in Europe, considerable foot troubles occurred in the American units who served with the British Army, because they were not accustomed to the stiff shoes provided in that service.

The feet should be washed every day and clean socks put on, the pair taken off washed, dried and kneaded smooth to avoid wrinkles and rough spots. The feet may be soaped or dusted with talcum powder to lessen any friction before starting in the morning. A careful foot inspection by the company officers after each day's march will give wonderful aid in keeping up the efficiency of the command.

F. S. R., U. S. A., provide that the rate of march of a mixed command is regulated by that of the foot troops; it varies with the length of the march, size of the command, condition of the troops and roads, weather, etc.

For infantry, the rate prescribed for drill is 100 yards per minute, or 3.4 miles per hour. On the road the maximum to be counted on is 80 yards per minute, or including halts about $2\frac{1}{2}$ miles per hour.

The average march of infantry or of mixed commands with foot troops is 15 miles per day, and in large bodies about 12 miles per day. Small commands of seasoned men, in cool weather and over good roads can average 20 miles per day. A maximum day's march for infantry and trains is about 28 to 30 miles, but this rate cannot be maintained. A uniform rate of march is of great importance, men tire very quickly with irregular gaits and rates of speed.

To rest the men and animals, a command on the road is occasionally halted. The first halt is made after marching forty-five minutes and is fifteen minutes long to enable men to answer the calls of nature, adjust equipment, etc. After the first rest, there is for foot troops a halt of ten minutes every hour; that is, the troops march fifty minutes and halt ten. Places for halts should be selected with care, and should be made as much as possible outside of villages, towns, etc., so that their purpose may not be defeated. In very hot weather, the halts may be longer and more frequent. The men are allowed to fall out, generally on the right side of the road, leaving the other side clear for passage of vehicles, messengers, etc. They are required to remain in the immediate vicinity during the halt, and to resume their places in the ranks at the command "Fall In."

As a rule, troops prefer to finish a day's march as soon as possible, hence, an early start is made, and lunches carried if the march will run well into the afternoon. A halt for one hour near meal time is advantageous. Portable kitchens that carry enough food for 250 men are sometimes provided; the meal is started before the march begins, and is cooked during the morning, so that when a noon halt is ordered, a hot dinner can be served. Fresh water to fill canteens, and for cooking purposes is also carried in water casks, this being essential in countries where water is scarce, or where the wells and streams have been poisoned by the retreating enemy.

Precautions are taken to prevent excess in eating or drinking, especially during a halt near a village or town. Canteens should be filled with water that is known to be safe before the men start, and with proper training a canteen of water should last one man for a day's march. Untrained troops drink at every opportunity, especially any-

thing in fluid form that is ice cold, the results of such practice being very soon evident.

Soldiers should be trained to be economical in the use of water, and to only use a very small quantity at a time while marching; the dryness of throat and sensation of thirst can be controlled to a large extent by carrying a small pebble in the mouth to excite the flow of saliva; large draughts of water while giving relief for a time soon cause the man to become waterlogged. When canteens must be replenished during a march, it should be done by order, and the sources of the supply examined by experts before use. This applies particularly in countries where cholera is endemic.

A source of great hardship on a march for foot troops is hot weather and dry dusty roads. Every precaution should be taken to prevent suffering from this cause. Green leaves or a moist handkerchief in the hat, opening the column in the middle so as to allow a current of air to pass down the center (foot troops march four abreast, a formation known as column of squads) and frequent halts in shady places are helps.

When men are overheated care must be taken to prevent their being chilled by exposure to cold winds or draughts during halts. No men are allowed to leave the ranks without permission, it being the duty of all officers to prevent straggling. Marches are generally regulated when practical so as to arrive at destination two or three hours before dark to allow for making camp and preparing a meal before night.

Night marches are sometimes made in hot weather to avoid the heat of the sun, but they are usually due to military necessity. All night marches rapidly impair the efficiency of a command. Moonlight and good roads are favorable, and special effort is needed to maintain march discipline.

During all marches, when it is necessary for a man to fall out on account of sickness or other cause, he is given a permit to do so. This is presented to the surgeon following in the rear of the column, who will direct him to the ambulance or care for him in other ways.

TRANSPORTATION BY RAIL.

Troops may be moved by rail over commercial or military railways. The former condition will obtain in all movements in time of peace, and for most concentration movements in time of war. In the theatre of military operations and along lines of communications, military railroads are used. Transportation is usually furnished at the rate of 3 men to each section in tourist sleepers, or 3 men to each two seats in day coaches. When day coaches are used for a journey of over twenty-four hours' duration, an effort is made to provide an entire seat for each man. Trains of moderate size and good speed are preferred to long trains with low speed. Units are kept together with all their equipment, as much as possible, an officer accompanying each section. In the European campaign, most troop movements were made in ordi-

nary box cars, which held about forty men. There was more or less crowding and discomfort as the trains were heavy and very slow. Very little could be accomplished in the way of personal hygiene on these trips which lasted two or three days at a time, and advantage had to be taken of the frequent stops to allow the men to leave the cars for short periods of time. There were no toilet accommodations on these trains, and no water except what was carried in the canteens of the command. Some cooking was done by means of portable kitchens placed on flat cars.

The medical officer is principally concerned before the troops entrain in seeing that the cars are clean, supplied with water and ice, and sufficiently lighted and heated. Urinals and closets must be in good condition and well supplied with water and toilet paper.

The name of the organization and number of men allotted to each car should be plainly chalked on the side. Sentinels are placed at each door of the car to prevent the men from exposing themselves to danger by riding on platforms, jumping from trains during halts, etc.

If it is desirable to exercise troops, they should leave the cars in a body under their officers.

In journeys of more than twenty-four hours, kitchen cars are provided, if possible; otherwise, baggage cars are fitted up with the usual stove used in camps. A car is used by two companies, each occupying one half. A heavy wooden box, about a foot deep is made which is lined with tin, this is fastened to the floor of the car and filled with sand, and on top of this a layer of brick; the stoves are put up on these boxes, the wood fires lying on the brick; a stove pipe is carried up and out doors through the ventilator transom in the top of cars, ends of pipes turning toward rear of train to secure good draught. Enough wood is cut to last a few days and the provisions to be used are piled conveniently near, leaving a passage way in the center, so as to be able to pass through the train, and not piling the material more than five feet in height to avoid its falling on those employed in the car during sudden movements of the train.

For short trips, provision can be made to secure hot coffee and sandwiches along the route for the command.

During the journey, the medical officer watches the sanitary condition of the cars, the means provided for personal cleanliness, sleeping accommodations, and the manner of preparing and serving the food provided. The nature and quality of the food to be used should be looked after before the start is made, troops should always have several days' rations in advance to be used in emergencies.

Trains are usually made up so that the kitchens are near the companies. A train for a battalion of four companies would be made up as follows, allowing each company three cars for the men: Locomotive, four freight cars (one for each company baggage), three tourist or sleeping cars, baggage car with kitchen for two companies; six tourist or sleeping cars, baggage car for two companies; three tourist or sleeping cars and car for officers at the rear.

With such an arrangement, the men of each company can go directly to their kitchen car, without passing through the cars occupied by another unit. Men should remain seated during mess and the food brought to them directly from the kitchen cars by appropriate details large enough to serve all without undue delay.

A medical officer and members of the sanitary detachment accompany each train, and provision is made to leave a few berths or sections in one of the cars for the care of any sick or injured.

The senior line officer on the train is in charge and responsible that order is maintained.

Special hospital trains are fitted up on each line of military railroad.

TRANSPORTATION BY WATER.

In estimating the transport capacity of ships it is customary to allow three to four gross tons per man and eight to ten per animal for ships of more than 5000 tons, and four to five per man, and ten to twelve per animal for smaller ships. This allowance includes rations, water, forage, etc., for the voyage and leaves a margin for reserve supplies.

F. S. R. provides that if practicable, all transports carrying troops or animals shall be supplied with distilling apparatus adequate for the supply of water required, and as a reserve in case of emergency, a distilling ship furnished by the Navy shall, if practicable, accompany each convoy.

An officer from the Navy controls the movements of the vessel, the commanding officer of the troops being responsible for the discipline and administration of his command.

The problem confronting the medical officer on transports is the close crowding necessary, the berths for the men being arranged in tiers with very little room in between, and the crowded decks giving few chances for physical exercise. Early in the trip, and during storms, sea-sickness is a factor, and means must be taken to keep the troops' quarters free from vomited material. Ventilation and sanitary conditions of the sleeping quarters require close attention, and also daily inspection of the men to detect illness or vermin.

The arrangements for feeding the men require close attention. During the late War, on account of submarine activity, ships had to run from dusk to dawn without lights; hence, many times on a crowded transport only two meals a day could be prepared and served during the daylight hours.

The men should be divided into small companies and distributed over the ship so all can be fed at the same time. Provision should also be made for disposal of waste food left on plates and cleaning of mess kits.

Special attention must be given to the water-closet accommodations on board, to see that they are kept well flushed and clean. Special egg-shape troughs, placed with large end down, are best for this purpose, as the contents are not so likely to be spilled out on the floor of the

apartment with the rolling of the ship. When it is considered that we must allow about two men a minute to use these closets, this necessary care is obvious.

The deck space must be so divided among the men that it can be utilized for programmes of enforced physical exercises during days of good weather. The frequent assembling of those on board to assigned places on the ship for emergency drills is also of importance.

EQUIPMENT.

During the movements of troops the things needed for their shelter, protection, food and comfort, have to be considered, and are usually the time factor in the general plan. It takes more time to take down, pack and load into trains or wagons, the tents, cots, stoves, rations, forage, etc., than it does to move the men.

In actual campaign, the soldier carries much of his equipment with him, and this may weigh, including rifles, bayonet and ammunition, from forty to sixty pounds. Efforts have been made in the construction of the 1910 pack to distribute the load over the body in such a manner that it can be most conveniently carried, and least impede the movements of the soldier, the old blanket roll and haversack having been generally discarded. During marches, when practicable, an effort is made by use of company wagons, to relieve the men of as much weight as possible, and in train or boat movements, only the necessary articles are taken on account of lack of space, the balance being packed and shipped.

During battle the complete equipment is worn as much as possible, the pack furnishing considerable protection to troops against shrapnel when lying down. It was observed during battles in the late War that the men had a tendency in a fight to throw away everything that encumbered them so they would emerge from a two or three days' conflict with only torn clothes and a rifle left of their equipment.

In addition to his arms, clothing, etc., each soldier carries a so-called "first aid packet" which consists of two sterile compresses and bandage placed in a hermetically sealed metal case, about two by four inches, with an arrangement for easy opening. Every man is supposed to know how to use and apply this first aid in case of emergency, and it is one of the duties of a medical officer to see that such instruction is given.

SHELTER.

At permanent posts or stations, the garrison is usually housed in wood or stone buildings called barracks, at concentration or mobilization camps, either in semi-permanent structures called cantonments, or under canvas, in the field under canvas and during campaign, long marches, or in the presence of the enemy, in so-called shelter tents or bivouac.

At a permanent post or station, the principles of hygiene are the same as would apply to any collection of buildings occupied by large numbers of men. These buildings are usually constructed with their purpose in view, and are supplied with water, light, heating facilities, etc., and the means for proper ventilation.

The only problem presented to the medical officer outside of general sanitation, is to see that these appliances are maintained in effective condition, and that the unavoidable close contact of the inmates is closely watched to check the spread of any communicable disease which might be introduced into the community; for this reason, separate buildings for each organization are desirable.

Plans and specifications used in construction of barracks for the U. S. Army, can be obtained from the Chief Supply Officer, U. S. Army. Buildings used as cantonments are usually of wooden construction and without the conveniences of those at permanent posts. The men are more likely to be crowded and the problem of general sanitation increased. Attention should be given to the mess-halls and kitchens, the places provided for laundry work, and excreta and garbage disposal.

Mobilization camps, as their name implies, are used for the gathering of troops from different centers in time of war, and are always more or less congested. One of the serious problems to be met with by the medical officer in charge is epidemics of measles, mumps and other communicable diseases brought in by regiments composed largely of non-immunes from isolated districts. Concentration camps are used to collect bodies of troops together previous to embarkation for a foreign port, or entrance upon a campaign in proximity to the enemy. The men in these camps are more likely to be seasoned troops, and to have received their immunizing inoculations for typhoid and paratyphoid and also to have been successfully vaccinated.

The medical officers' problem in these camps is usually one of general sanitation and to minimize the effects of crowding as much as possible.

When an organization is under canvas in the field, the problem of water supply and effectual refuse, excreta and garbage disposal arise; also, the not less important factor of good food properly cooked and served. Most of the diarrhea and digestive disturbances of camp life can be traced to neglect of this subject.

It is not a rare thing to visit a company kitchen and find the cereal burned or half cooked, the potatoes raw in the center, and the meat fried to a crisp and coated with grease. The cooking on the present stoves furnished in the army is limited to boiling, roasting, baking and frying, but most army cooks use frying to the exclusion of all others, and thus increase the indigestibility of the meals served.

Tentage issued to organizations at the present time consists of the shelter or dog tents which are carried in the pack by the men and the larger pyramidal and wall tents used in more permanent camps. The pyramidal tent is issued in two sizes, the larger 16 feet square and 11 feet high to top of roof, and the small 9 feet square, and 8 feet high to

top of roof. They are supported by a central pole resting upon a folding tripod, and held above by four chains hanging from a plate passed over the spindle of the pole. There is an opening in the top closed by a movable canvas hood operated by guy ropes from the outside. During cold weather, when stoves are used in the tents, a hood of sheet iron is provided to prevent fire from an overheated stove pipe.

The larger size tents are used for the men and will hold a squad (7 men and corporal) with cots for each man very comfortably; in a crowded camp, 15 to 30 men sleeping on the ground can be put into each tent, althought for sanitary reasons, such a course is not recommended.

The small tents are used for officers, one or two occupying a tent. Wall tents are generally used by officers of the higher grades and are $8\frac{1}{2}$ feet high and about 9 feet square, the advantage over the small pyramidals being that the tent is supported by a ridge and two end poles, the center of the tent being clear. An extra piece of canvas called a fly and fitted over any of these tents adds to comfort of the inmates by affording additional protection against extremes of heat and cold.

All tents are made of extra heavy canvas and of a brown color, which protects the eyes from the glare of the sun, shades in with the landscape and adds to the invisibility of the camp, and is a great improvement over the white tentage previously issued. The hospital tent is a wall tent of larger size, 11 feet high to ridge, and about 14 feet square. It accommodates five to eight cots.

Shelter Tents.—Each enlisted man in heavy marching order carries as part of his equipment, one-half of a shelter tent. To pitch these tents, the command is formed in double rank, and a single tent made by the front and rear rank men buttoning their halves together. The tent is occupied by two men sleeping on the ground, each having a space 3 feet by 6 feet to lie on.

The principles of hygiene to be observed regarding the tents themselves are to keep the ground space occupied by the tent scrupulously clean and dry, to allow no food to be brought into the tents on account of insects, to see that proper ventilation is provided at night, and that the material of which the tent is constructed is kept clean and in good condition. Each clear day, tents should be furled by wrapping the canvas around the center pole, which is supported by the guy ropes attached to the hood, all contents of tent removed, and the ground space exposed to rays of the sun for some hours. On cloudy days or at other times the sides can be rolled up so as to give a good current of air through the tent. Ventilation is secured during sleeping hours by leaving the hood open on clear nights, and through the door which except in extreme weather should be left unfastened. In case of communicable disease, the usual procedure has been to burn the tent. There is no reason, however, why a tent should not be soaked in a bichloride solution, and dried in the sun for purpose of effective disinfection.

THE SELECTION OF CAMP SITES.

Great care should be exercised in selecting a site. In general, the following principles govern:

The site should be convenient to an abundant supply of pure water. Good roads should lead to the camp, and interior communications throughout the camp should be easy. Nearness to a main road is undesirable on account of dust and noise. Wood, grass, forage and supplies should be at hand or easily obtainable.

The ground should accommodate the command without crowding and without compelling the troops of one unit to pass through the camp of another.

The site should be sufficiently high and rolling to drain off storm water readily, and if the season be hot, to catch the breeze. In cold weather, it should preferably have a southern exposure with woods to the north to break the cold winds. In warm weather, an eastern exposure with the site moderately shaded by trees is desirable. The site should be dry. For this reason, porous soil covered with stout turf and underlaid by a sandy or gravelly sub-soil is best. A site on clay soil or where the ground water approaches the surface, is damp, cold and unhealthful.

Alluvial soils, marshy ground, and ground near the base of hills, or near thick woods or dense vegetation are undesirable as camp sites on account of dampness. Ravines and depressions are likely to be unduly warm and to have insufficient or undesirable air currents.

Proximity to marshes or stagnant water is undesirable on account of the dampness, mosquitoes and the diseases which the latter transmit. The high banks of lakes or large streams make desirable camp sites. Dry beds of streams should be avoided as they are subject to sudden freshet.

The occupation of old camp sites is dangerous, since these are often permeated by elements of disease, which persist for considerable periods. Camp sites must be changed promptly when there is evidence of soil pollution or when epidemic disease threatens, but the need for frequent changes on this account may be a reflection on the sanitary administration of the camp.

A change of camp site is often desirable in order to secure a change of surroundings, and to abandon areas which have become dusty and cut up.

It is wonderful what can be done to change the aspect of a camp and to beautify the surroundings, by cutting out roads, the erection of fences, etc., by the soldiers themselves in a very short time. During an active campaign, tactical necessity leaves little choice in the selection of camp sites, troops often having to spend considerable time in mud and water, exposed to the elements without protection of any kind.

RATIONS.

A ration in the army is the allowance of food for one man per day (three meals).

There is no more important topic in military hygiene than the food of the soldier; nothing keeps the man in the army contented with his lot like a well-conducted mess. The components of the ration have been planned so that the essential quantities of proteids, fats and carbohydrates and an adequate number of calories are provided.

The government usually allows from 26 to 75 cents per day, per man, for feeding the army, depending on the station and the prices of food in the locality.

In the field there are three kinds of rations issued, namely, the Garrison ration, the Reserve ration, and the Field ration. The Garrison ration is intended for troops in garrison, camps, and wherever practical; it is as follows:

Component articles.	Quantities.	Articles that can be substituted.
Fresh beef	20.00 oz.	Fresh mutton, 20 oz. Bacon, 12 oz. Canned meat, 16 oz. Corned beef, 16 oz. Dried fish, 14 oz. Pickled fish, 18 oz. Canned fish, 16 oz. Turkey (Christmas Day) 16 oz.
Flour	18.00 oz.	Soft bread, 18 oz. Hard bread, 16 oz. Corn meal, 20 oz.
Baking powder	0.08 oz.	Rice, 1.6 oz. Hominy, 1.6 oz.
Beans	2.40 oz.	
Potatoes	20.00 oz.	Potatoes, canned, 15 oz. Onions, equal quantity. Canned tomatoes, equal quantity. Other fresh vegetables, equal quantities.
Prunes	1.28 oz.	Dried apples, 1.28 oz. Dried peaches, 1.28 oz. Jam, 50 per cent. total issue.
Coffee roasted and ground	1.12 oz.	Coffee roasted, not ground, 1.12 oz. Coffee, green, 1.4 oz. Tea, black or green, 0.32 oz.
Sugar	3.20 oz.	
Milk, evaporated, unsweetened,	5 oz.	
Vinegar	0.16 gill	
Salt	0.64 oz.	Pickles, equal quantity.
Black pepper	0.04 oz.	
Cinnamon	0.014 oz.	Cloves, ginger or nutmeg, equal quantities.
Lard	0.64 oz.	
Butter	0.5 oz.	Oleomargarine, 0.5 oz.
Syrup	0.32 gill	
Lemon extract	0.014 gill	Vanilla, 0.014 gill.

Quoting from Havard, "the fuel value in calories of the principal components is as follows:

Component articles.	Quantity in ounces.	Fuel value, calories.
Fresh beef	20.	1287
Fresh mutton	20.	1440
Bacon	12.	2040
Dried fish	14.	276
Pickled fish	18.	1029
Canned fish	16.	680
Flour	18.	1828
Soft bread	18.	1355
Hard bread	16.	1712
Corn meal	20.	1986
Beans	2.4	228
Rice	1.6	160
Hominy	1.6	172
Potatoes	20.0	368
Sugar	3.2	350
Lard	0.64	160
Butter	0.5	106
Syrup	1.3	192

By selecting the most nutritive articles such as bacon, hard bread, or corn meal, beans, potatoes, dried fruit, butter and syrup, we can obtain a maximum fuel value of 5378 calories, according to Langworthy, or 5674 carlories according to Wiley.

On the other hand by using such articles as dried fish, soft bread, rice, potatoes and canned tomatoes and dried fruits, the fuel value can be reduced to 2500 calories.

The average garrison ration habitually consisting of fresh beef, bread, beans, potatoes and onions, dried fruit, butter, syrup and sugar or their equivalents, weighs 65 ounces, and contains 99 grams of fat, 481 of carbohydrates and 157 of protein, with total fuel value of 3536 calories."

It has been found more economical for each unit of a regiment to provide its own mess. A company at war strength under the old system consisted of 150 men, and the field range was just about large enough to cook for this number. Under the French system with companies of 250 men, more heating surface and larger cooking utensils would be required. Some work has been done with fireless cookers and a battalion mess, the kitchen being on wheels, and the meal started before leaving camp and ready on halting, but with increased size of the units, this becomes impracticable, and the moving kitchen is more or less cumbersome, and likely to get stuck or lost on the road, and not be on hand when wanted. During the War with Germany, the rolling kitchen as used by the English Army, of a size sufficient to feed a company of 250 men, was utilized by some of the American units with considerable satisfaction.

The old system of individual cooking, where each soldier makes his own fire, and cooks his own meal, has been largely done away with, except in small scouting parties. It was wasteful of fuel, gave little or no variety of food, and the latter as a rule was badly cooked, and led to more or less digestive disturbances.

Each unit, at the present time, has a mess sergeant who is responsible for the drawing of rations and the daily menu. He has under him one or more cooks and several men detailed as kitchen police who assist in the preparation of the meals; the number of men working in the kitchen varies with the number of men in the organization to be served.

The company kitchen should be visited by an officer daily, and the menu for that day inspected, and the sanitary condition of the place well looked after. An officer should also be present at the serving of each meal, to see that the food is properly cooked, that sufficient variety is observed, and that each man gets his proper proportion. There is a wonderful difference in the meals of the different companies of a regiment, some of the units living in splendid style with well-cooked food and abundant variety, while others will have the cereals burned, the meat spoiled or swimming in fat, and the whole meal as unsavory and unappetizing as can be imagined. The responsibility for the meals belongs to the commander of the company, and the manner in which his men are fed is an index of his ability.

The medical officer is concerned with the kind of food served, and the manner of its preparation, the two factors being responsible for much of the digestive disturbances in the regiment; also the habits and personal cleanliness of those who prepare the food, and the fact that they may be carriers of some variety of disease.

The means provided for the cleaning of the mess kits of the men, and the way in which they are used, are sources of fruitful investigation. Every man should be taught the importance of washing his hands before each meal.

In hot weather, and where kitchens are not screened, the fly nuisance requires attention, and food has to be carefully watched and covered to avoid contamination.

The kitchen, cooking utensils, ice-boxes, store rooms, etc., need the usual sanitary inspection at frequent unexpected intervals.

The disposal of garbage and kitchen refuse will be taken up under another section, but it can be stated here that garbage is simply discarded food, and that if care is taken to provide proper well cooked meals and serve out the right size portion, the garbage problem will be much reduced, as the waste will be smaller. It is no uncommon thing in badly managed kitchens to find that the men throw away 50 to 75 per cent. of the food served to them.

When an organization is on the march during the day and halting at night, it is customary to provide two hot meals during the day, one in the morning before the start, and one at night after the halt, the soldier carrying a lunch provided in the morning which is eaten in the middle of the day.

The Reserve Ration is the simplest efficient ration and constitutes the reserve carried for field service. It consists of:

Bacon, 12 ounces.

Hard bread, 16 ounces.

Coffee, roasted and ground, 1.12 ounces.
Sugar, 2.4 ounces.
Salt, 16 ounces.
Approximate weight 2 pounds.

The Field Ration is the ration prescribed in orders by the commander of the field forces. It consists of the reserve ration in whole or in part, supplemented by articles requisitioned or purchased locally, or shipped from the rear. In campaign, a command carries as a part of its normal equipment, the following ration:

(*a*) On each man, at least two days' reserve rations.

(*b*) In the rations section of the field train for each man, two days' field and one day's reserve rations.

(*c*) In the supply train, two days' field rations.

In addition to the foregoing, commanders will require each man on the march to carry the unconsumed portion of the day's ration issued the night before for the noonday meal.

Reserve rations are consumed only in case of extreme necessity, when other supplies are not available. They are not to be consumed or renewed without an express order from the officer in command of the troops who is responsible for the provision of supplies. Reserve rations consumed must be replaced at the first opportunity.

Travel rations are issued in place of the ordinary ration when troops travel, otherwise than by marching, or when they are separated for a short time from cooking facilities and do not carry cooked rations. Sometimes when traveling, liquid coffee is provided at different train stops, and added to the cooked food carried.

The emergency ration consists of a condensed or concentrated mixture of nutritious foods in a hermetically sealed tin.

DRINKING WATER.

(The principles of water purification, etc., are fully considered in another portion of this book.)

A safe water supply is a necessity for the soldier, not only on account of the fact that it may be a medium for the transfer of pathogenic germs, but also to supply the needs of the body.

F. S. R. gives as approximate daily requirements:

1 gallon per man on the march.
5 gallons per man in camp.
6 to 10 gallons per animal on march or in camp.

The above figures apply to water taken from streams, where animals are watered at the streams, and cooking water carried. In estimating the daily supply for permanent or semi-permanent camps, where water is piped to kitchens, bath-houses, etc., the requirements will be 25 to 30 gallons per man and 10 to 15 gallons per animal, depending on climatic conditions. The quantity of water in streams may be estimated by the formula, $B + D + V + 10.800 =$ gallons in twenty-four hours.

B = average width. D = average depth. V = average velocity (all in feet).

I. D. R. requires that immediately on making camp, a guard should be placed over the water supply. If the water be obtained from a stream, places should be designated for drawing water as follows:

1—For drinking and cooking.

2—For watering animals.

3—For bathing and washing clothing.

The first named should be drawn furthest up the stream, the others in the order named down stream. If the stream is small, the supply may be increased by building a dam. Small springs may be dug out, and each cemented up or lined with a barrel or box with both ends removed, or with stones, the space between the lining and the earth being filled with puddled clay. A rim of clay should also be provided to keep out surface drainage. The same method may be used near swamps, streams or lakes to increase or clarify the water supply.

Water that is not known to be pure should be boiled twenty minutes. It should then be cooled and aërated (to remove flat taste) by being poured from one clean container to another, care being taken to avoid contamination, or it may be purified by approved apparatus supplied for this purpose. Arrangements should be made for men to draw water from authorized receptacles by means of a spigot or other similar arrangement. The dipping of water from the receptacles or the use of a common drinking cup should be prohibited.

The medical officer may assure himself of the safety of the source of the supply by the usual chemical and bacteriological tests, and by the more practical means of a sanitary survey, as the apparatus for the more complete methods are seldom available, and if they were, few medical officers in the army are trained in their use. In case only a small supply, as for a few men is needed, he can be reasonably sure in a friendly country by inquiring of the persons living near the stream or well as to the source of their own water supply. The average organization goes into camp laid out for it in advance with water piped to each company street, the purity of the supply being taken for granted because it is furnished that way. Unless the source of supply has been investigated by higher authority, the medical officer should assure himself of its purity as epidemics have been caused by neglect of such precautions.

The medical officer in the field is often confronted with the problem of supplying his command with water from sources which are contaminated, yet are the only supply available, and some simple method of making the water safe is needed.

There are three methods at his disposal for this purpose, namely, heat, filtration and treatment with chemicals.

Heating the water to the boiling-point is the surest and safest way of providing a safe article, but the method has many disadvantages. In the first place, it is almost impossible to so treat a supply sufficient for a large command; there will be a lack of containers in which to boil

the water, fires will not be made, the taste of the water is changed, odors come out more strongly on heating, and it takes a long time to get cool enough, especially during hot weather, to be palatable. Any method which will not supply an adequate supply of drinking water, within a short time after reaching camp will probably fail, as the men will usually drink anywhere in spite of the strictest supervision. On the other hand, if a march is to be continued the following day, it is very easy for each company to heat water on their fires after cooking supper sufficient to fill every canteen in the company with boiling water; the canteens are hung up over night, and a supply of sterile cool water for the march next day is provided; if the water is made into weak tea or coffee the taste and color are changed, and the men accept the article more readily.

Apparatus for the sterilization of water by heat is furnished of which the Forbes sterilizer is an example. Raw water enters a tube at one side, is exposed to heat furnished by an oil lamp with a vaporized flame, is partially cooled, and can furnish about 15 gallons per hour. The apparatus weighs about 100 pounds, and is $3\frac{1}{2}$ by 1 foot when packed, and requires one pint of oil per hour. Two barrels are needed, one for raw water and the other for the sterile product.

Filtration takes apparatus, either already made or improvised, and like boiling, takes considerable time for a sufficient supply of water to be provided, and it is not quite sure without suitable tests that all dangerous bacteria are eliminated.

Several varieties of portable filters are provided, but all apparatus of this kind is open to the same objections, they take up considerable space, which must be considered in transportation, may get lost or not arrive with the troops, and may be out of order with no materials at hand to fix them. The Darnall filter can be taken as a specimen of the different types of mechanical filters, and is one of the simplest and least likely to get out of order. The apparatus consists of a galvanized iron tank, two water cans, a siphon filter and cloth, and a small hand pump to start the flow of water, the whole filtering into a crate about two by four feet, and weight about 10 pounds. The tank is filled with raw water to which a coagulant consisting of alum and sodium carbonate has been added. (5 grains of alum to the gallon, the proportion of alum and sodium carbonate being just sufficient to neutralize each other.) The cotton fibric used for filtering is fitted over the metal frame work of the syphon, and placed in the tank, and the water after passing through the filtering cloth into the cylinder is discharged by means of the syphon into the filtered water can. The cloth covers used for filters should be sterilized by boiling from time to time.

If a camp is to be more or less permanent, regular filter beds can be built as is elsewhere described. An improvised filter for a small command can be made by two barrels, one of smaller size and open at both ends, and setting inside of the larger one. The large barrel is filled to a depth of one foot with small stones, and the small barrel with perforated bottom, placed on the center of the stones, a foot of gravel is now added

on the outside over the stones and on top of this 12 or 14 inches of fine clean sand. Water is introduced on the outside of the small barrel, percolates through the layers of sand, gravel, etc., and fills the smaller barrel with a fairly pure water. Such a filter requires frequent cleaning and removal of top layers of sand.

Pits can be constructed a few feet from the river's edge, where the soil is sandy, allowing the river water to percolate through the intervening space to fill them. The walls of such pits should be lined with clay or cement, and they should be protected from surface drainage.

Chemical treatment of water for drinking purposes may be applied in several different ways, the simplest for army use being to have the chemical (hypochlorite of lime being the best) in small vials or tablet form, and of such strength that each vial or tablet will sterilize so many gallons of water. The Lyster bag used in the army holds 40 gallons. A level teaspoonful of the chloride of lime is rubbed up well in a cup of water, which is further diluted by adding three cups of water, a teaspoonful of this last mixture will sterilize two gallons of raw water with little apparent taste or odor. The dilution is about five parts of chlorin to a million parts of water.

GENERAL SANITATION.

Under the head of general sanitation, we will speak of sanitation as it affects the soldier and his environment, commencing with personal hygiene, the hygiene of the camp and trenches, and lastly the hygiene of the battle field.

Personal Hygiene.—It is essential that the soldier should keep clean. In permanent camps, showers are usually provided, but during cold weather they are little used. Troops should be taught to wash the face, neck, feet, genital and axillary regions once a day with soap and water, and at least once each week to wash the entire body. The teeth should be cleaned with a good brush at least twice daily, and the mouth well rinsed out with clean water. Each soldier is supposed to keep himself clean, shaved and his hair kept neatly trimmed by the company barber.

Every man washes his own clothes, changes his underwear at least once a week, and as much oftener as may be needed. The company supply sergeant should see that the men are provided with enough socks and underwear to change as required. The uniform is kept repaired, clean, and pressed, and the shoes polished.

In most camps except in the presence of the enemy, work and drills are suspended for two half days a week, and all day Sunday. This time the soldier has for his own, so that his personal needs may receive attention.

Every man should be instructed as to the functions of his digestive organs and regular bowel habits formed and continued.

The formation of good moral habits is of great importance, and too much attention cannot be given to this side of a soldier's life. Men

should be taught to report at once to the medical officer when ill, and not try to cure themselves.

Camp hygiene resolves itself into the general sanitary conditions of the camp, the proper collection and disposal of refuse and garbage, and the treatment and disposal of human excreta.

Under the head of refuse is considered all the debris of a camp, pieces of wood, papers, discarded clothing, tin cans, rubbish, etc. All this is collected several times a day by what is called policing the camp. Lines of men move slowly across the camp site, picking up everything that comes under this head, and collecting it in some central place where it is burned. Tin cans are well burned in the fire, then flattened out with a mallet so they will not hold water, and carted to some designated place with other rubbish that cannot be destroyed by fire and then buried.

The ground around the corral where horses, mules and cattle are kept is cleaned twice daily, the surface burnt over with oil to destroy flies, and the sweepings either burned or removed to some place outside the camp limits, which is set aside for this purpose.

Garbage and kitchen refuse, both liquid and solid, require constant attention. Reference has been made elsewhere to the fact that this problem can be considerably lightened by proper attention to the preparation and serving of food, so there will be little or no waste.

The liquid slops from the kitchen, water from dishwashing, and the soapy water from laundries and baths is the hardest to dispose of. In sandy soils, they can be conducted to dry cesspools and thus disposed of but where the soil is impervious, some method of destruction by fire must be resorted to. The solid garbage can either be collected in cans and removed daily by contract with local farmers who use it for feed, manure, etc., or it can be burned. Simple devices can be constructed for this purpose, and every mess should care for its own garbage.

Most of the improvised crematories are constructed by heaping rocks in different shapes, sometimes flat, sometimes in a pit with a heap of stones in the center to serve as a chimney. A fire is built on these rocks and the solid garbage directly consumed, when the rocks get hot, the liquid slops are slowly poured on and turned into steam by contact with the hot surface.

This method requires constant attention and is wasteful of fuel; moreover, it must be thoroughly cleaned and reconstructed at frequent intervals. Another crematory has been made in which a pan is placed over the flames, and the liquid slops evaporated in this way, while the solid portions are burned underneath. This fire can also be used to heat water for the cleansing of mess kits, etc. Regularly constructed crematories for the destruction of garbage from cities and large camps will be described elsewhere.

The Disposal of Human Excreta.—For a large permanent camp, a regular sewer system should be planned with some means of treatment of the waste matter, as is described in other places.

Where troops are marching and halting for a few days, I. D. R. provides that immediately on arriving in camp sinks should be dug. This is a matter of fundamental sanitary importance, since the most serious epidemics of camp diseases are spread from human excreta.

One sink is usually provided for each company, and one for the officers of each battalion. Those for the men are invariably located on the side of the camp opposite the kitchens. All sinks should be so placed that they cannot pollute the water supply or camp site as a result of drainage or overflow. To insure this, their location and distance from camp may be varied.

When camp is made for a single night, shallow trenches 12 inches deep, and 15 to 18 inches wide, which the men may straddle, will suffice.

In more permanent camps, the trenches should be about 2 feet wide, 6 feet deep, and 15 feet long. They should be provided with seats and back rests made of poles, and should be screened by brush or old tent flies. In cold weather the contents of sinks should be covered once daily with quicklime, ashes or dry earth. When filled to within two feet of the top, sinks should be discontinued and filled in.

Open pits are dangerous during the fly season. However, this danger may be greatly reduced by covering the excreta with earth or by a thorough daily burning of the entire area of the trench. Combustible sweepings or straw saturated with oil may be used for this purpose.

In fly season trenches may be closed with seats, covered down to the ground with muslin and supplied with self closing lids. Urinal troughs made of muslin and coated with oil or paint should discharge into the trenches. Urinal tubs or cans are placed in the company streets at night to prevent the pollution of the adjoining ground which would otherwise happen. They are removed at reveille. Their location should be marked with a lantern, and the soil under and around them thoroughly and frequently disinfected. When troops bivouac for the night, the necessity for extensive sanitary precautions is not great. However, shallow sink trenches should be dug to prevent general pollution of the vicinity. If the cooking be collective, shallow kitchen sinks should be dug. If the cooking is individual, the men should be required to build their fires on the leeward flank of the camp or bivouac.

Before marching, all trenches should be filled in, and the camp site well policed.

In camps more or less permanent, boxed latrines are used and have been found to answer every purpose. A trench 10 to 12 feet long, by 2 or 3 feet wide, and 6 to 8 feet deep is dug. Over this a fly proof box of suitable size is built, with an appropriate number of seats, each fitted with a self-closing lid. The space between the bottom of the box and the ground is well banked up to exclude surface water and flies. Any cracks or knot holes in the lumber are covered over. One such latrine is built for each company of the organization at a place selected by the medical officer. The box is turned back once daily, the seats and top scrubbed with soap and water, and straw saturated with oil burnt in

the pit, or else the entire surface of the pit and inside of the box is sprayed with kerosene and lampblack, by a detail from the sanitary corps.

A funnel with a strainer at the bottom is connected with a trapped pipe leading to the trench and is used as a urinal. This is also cleaned and oiled daily.

Efforts have been made to destroy all excreta in specially devised incinerators, of which the McCall is a type. The objection to these is the weight and difficulty of transportation, and the quantity of fuel or oil needed for the combustion.

Toilet paper in rolls, placed in boxes to protect it from the weather, should be furnished, and care observed that loose portions should not be scattered around the latrines or blown over the camp site.

Trenches.—When trenches are constructed for more or less permanent occupation, provisions for drainage must be observed, and also means provided to prevent surface water running into them. The problem presented depends entirely on the location of the trench, and the nature of the soil. As trenches are constructed as a military necessity, with little regard for hygienic principles, the situation at times is very discouraging to the medical officer. It is not unusual for the men occupying trenches in low ground to be waist deep in water during heavy rains. Efforts are made during construction, however, to slope the floor of the trench so that water will run along the rear to dry cesspools, or be disposed of by under-drains or sumps to some suitable place that may offer.

Latrines are placed in the angles of communicating trenches, so they may be readily reached by the men. The pail system answers best for this purpose. When men are required to live for some time in dugouts, which are at least 20 to 35 feet deep, almost all sanitation is sacrificed to secure protection from the fire of the enemy. The air is apt to become close and foul, and the only thing that can be done is to make the stay of each unit as short as possible in such location. They are usually constructed with a tier of wooden bunks on each side on which the men rest. Periscopes are also used as ventilators.

HYGIENE OF GAS ATTACKS.

Modern warfare has recently utilized different varieties of gas as a means of offense and defense.

The first use of such a weapon was in an attack on April 22, 1915, by the Germans at Ypres, on a sector of trench occupied by French and Canadian soldiers; the number of casualties was enormous.

Gas is used in the form of a cloud, which a favorable wind will carry toward the enemy after it has been released from its liquid form in cylinders buried under the trenches, or by means of gas shells which explode within the enemy's line and scatter the liquefied gas. The heavier gases are utilized on account of slow diffusion. They are

roughly divided into three groups, according to their effect on the human body as follows:

(*a*) Lachrymatory.
(*b*) Asphyxiating.
(*c*) Paralyzant.

A great variety of acids may be used for the production of gases, and chemists in all armies are constantly experimenting with a view to successfully combating their use, and perfecting new and more potent combinations. The ones most commonly used at present for the suffocating and lachrymatory group are combinations of benzol and acetone with chlorine and bromine.

The deadly character of gas attacks can be almost entirely obviated if the proper measures of protection are known and strictly enforced. This implies a familiarity with the different varieties of gas masks used, the principle of all being the fact that the inspired air is drawn through different layers of chemicals in the bottom of the mask which neutralize or absorb the dangerous gas. Effectual means of sounding the alarm, when a gas attack is impending are also important. Some gases, as carbon monoxide are colorless, odorless and tasteless. During an attack, the command is kept as quiet as the military situation will allow, all marching ceases within an area of three miles, and all within this limit wear and use their masks. Wounded men are watched to see that they do not tear their masks off.

The only way in which dug-outs and cellars can be cleared of gas is through ventilation by means of fires and gas fans. A sprayer has been used with an alkaline solution which neutralized chlorine, but with the advent of other gases, its efficiency was lost, and it is now only useful in wetting the blankets which hang at each dug-out entrance as a protection against the entrance of gas.

The defenses used against gas attacks in our army are under the direction of the medical department, and it is charged with the duty of providing gas masks, resuscitation apparatus, etc. The chemicals through which the poisoned air is inspired must be renewed from time to time, according to their use. Most masks can be used from twelve to seventeen hours continuously without recharging. The men must be well drilled in the use and adjustment of the masks. They are supposed to be put on within six seconds by each individual.

The hygiene of the battle field may be divided into two portions; first, the precautions which the individual may take before going into action, and later, the removal and care of the wounded and disposal of the dead.

Each soldier, if possible, before going into battle, should be as clean as possible both in body and clothing, to prevent possible infection if wounded. His bowels and bladder should be empty, and he should be sure to have his canteen filled with good water, and be provided with a first aid packet.

If seriously wounded, he will do better to remain where he fell until picked up by litter bearers, than to try and reach help himself, and

perhaps aggravate his injury. Unless the battle line is at a halt, he cannot expect much help from his surrounding comrades, except perhaps to bandage him up and leave him in a comfortable position.

I. D. R. states that "when officers or men belonging to fighting troops leave their proper places to carry back or to care for wounded during the progress of the action, they are guilty of skulking. This offense must be repressed with the utmost vigor."

With the above in mind the necessity of each man being provided with a first-aid packet and the knowledge of its proper use is apparent. First aid stations are established by the medical corps as close to the firing line as possible, and are advanced as that line progresses. The duties of this department become more arduous as the battle closes, for on them rests the responsibility for the removal of the wounded and the sanitary control of the battle field.

The dead are collected by details of troops and disposed of by burial, or otherwise, as the commander may direct. Large numbers of dead animals, as horses and mules, may also have to be disposed of by fire or burial. F. S. R. provides that no body shall be buried or otherwise disposed of until identified if such is possible.

Before a command enters upon a campaign, every member thereof is provided with an identification tag, by which he can be identified if killed or wounded. These tags are made of aluminum with the man's name stamped on them, and are worn suspended around the neck. Such tags are not removed from the dead but are left on the bodies when interred or otherwise disposed of. Tags found on the bodies of the enemy's dead are collected and turned over to the commander of trains who send them to the provost marshal at the base.

THE PHYSICIAN IN THE ARMY.

Medical officers were formerly called surgeons, but as our knowledge of hygiene has advanced the great importance of this subject to an army has been recognized, and at the present time, the practice of surgery is usually confined to the base and field hospitals; the medical officer who accompanies the troops does little of this work, simply giving first aid, meeting emergencies, and passing his patient on to the place provided. He is now primarily a sanitarian, and the greater part of his work runs along the lines of hygiene, sanitary science and preventive medicine.

The medical officers of today have a recognized rank. They generally enter the service as first lieutenants, and gradually rise through the grades of captain, major, lieutenant-colonel and colonel, and he may become the surgeon general. His rank corresponds with that of the officers of the line and staff, but he does not command troops outside of the sanitary detachment.

Medical officers are generally attached at the rate of four to a regiment of 2002 (old tables of organization). In addition ambulance companies, field and base hospitals are organized and manned by the

medical department. Dental surgeons are now attached to the sanitary corps, and the teeth of the men are well looked after. Frequent inspections of the command should be made to detect diseased teeth.

F. S. R. defines the duties of the sanitary service in the field as follows:

1. The institution of all practicable sanitary measures to the end that the fighting forces suffer no depletion in strength due to avoidable causes.

2. The temporary care and professional treatment of the sick and wounded and their transportation to accessible points, where they are transferred with as little delay as possible to the line of communication.

3. The supply of the necessary sanitary equipment. In addition the sanitary service is charged with the preparation and preservation of individual records of sickness and injury in order that claims may be adjudicated with justice to the government and the individual.

The personnel of the sanitary service in the zone of the advance may be classified into two general groups. First, that attached to organizations smaller than a brigade which functions under the immediate orders of the organization commander and accompanies its units into combat. Second, that attached to the sanitary train which functions under the orders of the division surgeon in accordance with such general or specific instructions as he may receive from the division commander.

When necessary, the sanitary personnel attached to organizations may be temporarily detached in whole or part, and directed to operate with the sanitary train.

Sanitary officers and men of all arms must have a knowledge of sanitation and its importance to the end that no depletion of the fighting force occur through avoidable causes. The importance of adopting and carrying out proper sanitary measures cannot be overestimated.

Commanders of all grades are responsible for the sanitary condition of the quarters or localities occupied by their commands, and for the enforcement of all sanitary regulations. In addition, they are responsible that all sanitary defects reported to them are promptly corrected.

A medical officer of experience designated sanitary inspector is charged under direction of the division surgeon with investigating and reporting upon the sanitation of the division, to which he is attached. Sanitary inspectors report the result of their inspections to local commanders, as well as to the division surgeon.

First-aid Packet.—Every man with the division carries a first-aid packet. The sanitary detachments with organizations carry pouches containing appliances for first aid and stimulants. The combat train carries litters and the necessary equipment for regimental aid station.

Regimental Aid Station.—This station established by each regiment or independent battalion during combat, and when justified by the number of wounded, is the place to which all wounded of the organization are carried by its sanitary personnel, and where emergency treatment is administered. The position of the station is fixed by the organization commander, and is as near the firing line as possible. This station will often be but little more than a place for assembling the

wounded, as its personnel belongs to the organization and therefore must be prepared to move with it. After receiving emergency treatment all wounded, able to walk (except those with trivial wounds who are sent back to the line) are directed to the station for slightly wounded; those unable to walk are delivered to the bearers sent forward from the sanitary train.

The equipment of the regimental aid station is carried on the combat train. It is operated by the sanitary personnel of the organization.

Dressing Stations.—These stations established during combat by ambulance companies of the sanitary train in the immediate rear of the line of regimental aid stations, are the places where all wounded, unable to walk, are collected from regimental aid stations by bearers of ambulance companies. If conditions so warrant, these bearers may be assisted in their work by portions of the organization sanitary personnel. From these stations the wounded are transported by ambulance companies back to field hospitals.

The equipment for dressing stations is more elaborate than that of the regimental aid station. It provides light nourishment and stimulants for the wounded, and affords facilities for more elaborate dressings and for emergency surgery. The equipment for dressing stations and the necessary personnel are supplied by the ambulance companies of the sanitary train.

Ambulance Companies.—Ambulance companies push up close to the rear of the fighting troops and as near the line of regimental aid stations as possible, and establish dressing stations. In addition to their functions at the dressing stations, they are charged with the transportation of the wounded back to field hospitals, and with providing the necessary equipment for infirmary service in camps. When field hospitals have not been set up and when sanitary columns or railway hospital trains of the line of communications are reasonably accessible, ambulance companies transport the wounded directly to them.

Field Hospital Companies.—Field Hospital companies form part of the sanitary train. They are set up when conditions so warrant, ordinarily some three or four miles from the battle field, and are the places to which the wounded are transported by ambulance companies. Their position must be one accessible both from the front and rear, and where good water is available. Field hospitals are not set up when the sick or wounded can be turned over conveniently to elements of the sanitary column or railway hospital trains of the line of communications. Canvas is pitched, only when buildings are not available or are inadequate for the purpose of housing the wounded.

The equipment of the field hospitals, while more elaborate than that of dressing stations, and while providing canvas for protection of the wounded from the weather, and facilities for more extended surgical work, is nevertheless limited to providing necessities for the sick and wounded, pending the evacuation to the rear by the line of communications.

Evacuation Points.—The sanitary column of the line of communications includes ambulance companies and evacuation hospitals; there also may be available railway hospital trains and boats, any or all of which may be used as the means for the evacuation of the sick and wounded from the division. The places at which the sick and wounded are transferred from the division to the line of communication elements are termed evacuating points. The position of evacuating points are fixed in the same manner as is the refilling points of the supply service (by division commanders), and communicated directly from division headquarters to the commander of the sanitary train.

Stations for Slightly Wounded.—A station for slightly wounded is established when combat is imminent, to relieve dressing stations and field hospitals of the slightly wounded who can walk, and require but little attention. Its position is fixed in division orders. It is operated by the personnel of the sanitary train detailed for the purpose. It is conspicuously marked so that it can be readily found.

The Sanitary Train.—The sanitary train is composed of ambulance companies, field hospital companies and camp infirmaries. The sanitary train is commanded by the division surgeon (lieutenant-colonel) or, in his absence, by the senior medical officer of the attached elements, who, upon its release from the control of the commander of trains operates it in accordance with orders or instructions received from division headquarters.

Service in Camps.—In camps an ambulance service is furnished from the sanitary train. Infirmaries are set up at convenient points by order of the division surgeon, and operated by the sanitary personnel attached to the organization which the infirmary serves. Here cases not requiring hospital treatment are cared for, all other cases being promptly removed by the ambulance service. The senior medical officer of the units served by the infirmary, assumes charge of the same, and is authorized to call directly on the other organizations for their proportionate share of medical officers and sanitary personnel for the infirmary service. The sergeant, hospital corps, detailed with the infirmary, remains with it in charge of the equipment. If necessary, field hospitals are set up for the reception of the seriously sick or wounded.

Service on the March.—When out of the presence of the enemy, ambulances are ordinarily ordered distributed by the division commander throughout the column, in the rear of regiments, battalions, etc. A camp infirmary is assigned to each brigade, and marches in its rear, and a field hospital should be so located in the column of march as to permit of its being available for the reception of seriously sick and injured, as soon as possible after the arrival of troops in camp.

During marches in the presence of the enemy, ambulance companies are kept intact. It may be advisable to assign one or more of these companies to a position in the column of the combatant troops, but any further dispersion is inadvisable. When combat is imminent, and when so ordered by the column commander, the ambulance com-

panies fall out of the column, and as soon as the combatant troops have passed, they take a position assigned in the rear.

A man falling out from sickness or injury, is sent with a pass showing his name, company and regiment or corps, to the medical officer in the rear. The latter returns the pass, having indicated thereon the disposition made of the man. If the man is unable to walk, he is picked up by the first ambulance and cared for. If able to walk, he may either be required to follow immediately behind his organization or ordered to await the arrival of the sanitary train. In the latter case he is furnished with a tag, showing the orders given him.

The arms, personal equipment and clothing of soldiers who fall out are carried with them.

The horse, saber and horse equipment of a mounted soldier admitted to the ambulance or otherwise disposed of, are taken back to the troops by the non-commissioned officer that accompanied him.

Service in Combat.—In the absence of medical assistance the wounded apply their first-aid packets, if practicable. With this exception the care of the wounded devolves upon the sanitary troops, and no combatant unless duly authorized is permitted to take or accompany the sick or injured to the rear. The sanitary personnel of organizations must remain with it when advancing into action, and during the whole course of an engagement. Accordingly, the wounded will be treated where their wounds are received, and the sanitary personnel will pause if the organization is moving, only so long as is necessary to give appropriate first aid. At a later stage of the combat, when the movement of the organization permits, and when justified by the number of wounded, a regimental aid station is established and operated. When combat is imminent, the station for slightly wounded is announced in division orders, and thereafter it is to this station that all disabled men able to walk are ordered to report. They are furnished with a tag, showing the orders given them by the medical officers, authorizing their proceeding to this station.

The evacuation of the wounded from regimental aid stations when established, and the evacuation of the wounded left by the organizations during an advance, when a regimental aid station has not been established, devolves on the personnel of the sanitary train.

In the case of a deliberate attack on the enemy in position, or when our forces occupy a defensive position, the positions of dressing stations are fixed in orders by the division commander, and communicated to the troops. The division commander in this case advises the commander of the sanitary train, as to the position of the field hospitals. In the case of an unexpected engagement, the work of establishing dressing stations, field hospitals, and of evacuating wounded during combat from the dressing stations to the field hospital, or in certain cases directly to the line of communications, must be left to a great extent to the initiative and judgment of the commander of the sanitary train and his subordinates.

To this end, the commander of the sanitary train sends forward one

or more ambulance companies, to make contact in certain prescribed areas with the sanitary formations of the combatant units. When ambulance companies have been assigned positions in the column of march of combatant troops, they are usually utilized in this work. The remaining ambulance companies ordinarily accompanied by one field hospital, and under the immediate command of the sanitary train commander follow, and are held together in reserve at a certain prearranged position selected by the sanitary train commander, and by him communicated to the commander of the ambulance companies sent ahead. The other field hospitals remain for the time being under the control of the commander of trains, to be brought forward later if required. The ambulance company commanders ordered to make contact with the combatant organizations push forward agents for the purpose of sanitary reconnaissance, and for arranging for the position of the dressing stations, and for determining the best line of approach to them.

When so ordered they establish dressing stations and commence collecting wounded from the different regimental aid stations, ultimately sending them back to the field hospital at the prearranged point.

The commander of the sanitary train keeps himself advised by means of agents of the progress and development of the battle and the number of casualties in certain areas, and from these reports, and from orders received from the division surgeon, he pushes forward additional ambulance companies when required, prescribing the area of their respective activity, and the point to which their wounded are to be transported. At the same time he may order forward such additional field hospitals as may be required.

Search for Wounded.—After an engagement, commanders organize a thorough search of the battle field in their vicinity for the wounded, and assist in their protection and removal. The dead are collected by details from the line as soon as practicable after the battle and disposed of as the commander directs.

Retreat.—In a retreat such portion of the sanitary personnel of the division as is required, will remain with the sick and wounded that cannot be moved, under the protection of the Red Cross flag.

American National Red Cross Association.—The service of the association, its equipment and personnel are utilized under the immediate direction of medical officers, to the greatest extent possible in the care of the sick and wounded in the service of the interior, and in the line of communications. Their services are not utilized in the zone of the advance.

Badge of Neutrality.—The emblem of neutrality is a red cross on a white ground. All persons belonging to the sanitary service, including the red cross association personnel and chaplains attached to the army, wear on the left arm, a brassard bearing this emblem stamped by competent authority.

Those not uniformed carry a certificate of identity, in addition to

the brassard. All sanitary formations and establishments display a Red Cross flag, accompanied by the national flag.

At night the positions of sanitary formations are marked by green lanterns.

DISEASES OF THE SOLDIER.

There is nothing peculiar in the diseases of the soldier. As would be inferred, he is most subject to those infections, which are spread by close contact, and which can be conveyed through food and drink. Bowel inflammation, dysentery, typhoid and paratyphoid, are types of such infection. The American soldier at the present time is inoculated against typhoid and paratyphoid and is properly vaccinated. Some work has also been done along the lines of protective inoculation against pneumonia.

Common colds and sore-throats are often prevalent during spells of bad weather, due to exposure and close crowded tents. Diseases of the respiratory tract, bronchitis, pneumonia, influenza and tuberculosis are not uncommon. Tuberculosis is usually due to the breaking down of some old undiscovered lesions, from hardship and exposure.

The common communicable diseases as mumps, measles, meningitis, scarlatina, etc., often break out among troops from suburban districts, and spread rapidly in a crowded camp. An army stationed in any locality, must be guarded against the particular diseases of that location, as hookworm, dengue, yellow fever, etc., in the south; scurvy, frost bite, etc., in the far north; and cholera, typhus and plague in the countries where they are endemic.

The protection to be provided for the soldier is the same as has been described elsewhere for the civilian.

Skin diseases, pediculi and scabies are sometimes found in camps where personal hygiene is not strictly observed; cases of Rhus poisoning are not uncommon among fresh arrivals in a camp. Mental disturbances are of frequent occurrence in camps of mobilization, running from hysteria to melancholia. These are more often seen when troops are not kept fully employed.

Communicable diseases and those transmitted by contact are quickly checked by dividing the command into small isolated units with no communication between them, and at the same time observing such other precautions as are generally taken for the control of such infections.

On foreign service, diseases of nutrition as beriberi, etc., are to be guarded against.

Alcoholism and venereal diseases are sometimes prevalent in camps situated near towns or cities where liquor is easily obtained and the population is of low moral tone.

The passage of the law forbidding the selling of any kind of drink containing alcohol to a soldier, during the war with Germany, has made a great difference in the morbidity records of the American Army.

SCHEME FOR THE SANITARY SURVEY OF A CAMP.

Location.

Nature of surrounding terrain.
Direction of drainage.
Presence of marsh land, water, trees.
Pollution of water supply.
Direction of prevailing winds.
Proximity of dusty roads.
Accessibility, distance to railroad.
Mosquitoes.
Population.
Places of low moral character.
Presence of dangerous animals or reptiles.
Poisonous plants.

Camp.

Number of men.
Kind of shelter provided.
Number in tent.
Arrangement for drainage.
Condition of canvas.
How frequently are tents furled?
Condition of interior.
Sleeping arrangements (cots or ground).
Are the bed sacks filled with straw?
Condition of blankets and clothing (quantity per man).
Food in tent?
Mosquito bars.
Arrangements for heating.
Presence of illness.
Refuse disposal.
Camp roads and streets, drainage, cleanliness, dust.

Kitchens.

Water supply.
Provision for drainage.
Disposition of kitchen slops, garbage.
Firewood.
Stoves.
Store rooms.
Ice-box.
Protection for food (raw and cooked).
Kitchen enclosed (dust).
Presence of flies.
Cleanliness of interior and utensils.
Distance to latrines.

Number of men in kitchen, cleanliness, white suits, possible disease carriers.
Incinerators.
Garbage barrels.

Mess Halls.

Number accommodated.
Manner of serving food.
Waiters.
Cleanliness.
Table covering.
Light, heat, ventilation.
Flies.

Water Supply.

Source.
Precautions to insure purity.
Possible chances of contamination.
Is it boiled before using?

Food Supply.

Source.
Meat inspected.
Milk inspected.
Cooking.
Variety.
Waste.
Care of before and after cooking.
Canned goods.
Ice.
Food handlers.
Regularity of meals.
Well balanced ration.

Latrines.

Number.
Position in camp.
Size.
Variety.
Precautions taken to exclude flies.
Cleanliness.
Odor.
Toilet paper.
Privacy.
Urinals.
Number of men accommodated (size of command).
Precautions against surface drainage.
Contamination of any water supply.
Are disinfectants used?
Urinals in company streets at night.

CORRAL.

How many and kind of animals kept?
Condition.
Cleanliness.
Manure disposal.
Water supply.
Forage.
Shelter.

PERSONNEL.

Uniforms and equipment.
Personal hygiene.
Presence of illness.
Prophylactic inoculations.
Vaccination.
Extra underwear, socks, clothing.
Shoes, condition, fit, extra pair.
Condition of feet, hair, head and teeth.
Condition of canteen and mess kits.
Percentage of new men.
Daily routine.
Number of medical officers.
Facilities for care of sick.
Canteen, character of articles sold.

CHAPTER XXII.

RURAL PUBLIC HEALTH WORK.

By FRANK OVERTON, M.D., D.P.H., Sc.C.

There is a close similarity between public health work in cities and that in rural districts. The same diseases prevail in both sections, and the same human nature exists. It is a mistake to assume that a rural district is now more healthful than a city. The conditions which affect the health and vigor of a people may be divided into the environmental, or those outside of the body, and the personal, or those within the body. When people were ignorant of the causes of sickness, and were generally careless of public cleanliness, environmental conditions were unsanitary and unhealthful in proportion to the congestion of population. The death-rates of large cities before the days of efficient public health administration were about double those in the country. Public health work originated in cities. At first it was mainly environmental, and consisted in such measures as cleanliness of streets and yards, the disposal of sewage and garbage, and the installation of pure water supplies. These measures reduced the city rates for sickness and death to a marked degree, principally by preventing epidemics of those diseases which are associated with filth and water, such as typhus fever and cholera. A far greater reduction in the rates took place when the scope of public health work was extended to include the individuals themselves and the prevention of the spread of diseases by contact of one person with another. The result of the combined environmental and personal phases of public health work has been that the death-rates in large cities had dropped to the rate that prevails in rural districts. The death-rate in New York City in 1900 was 20.6 and in the rest of the State it was 15.5. The New York City rate in 1910 was 15.9 and in the rest of the State it was 15.8; and since that time the city rate has usually been below the rural. A great problem in public health work is to reduce the rates for death and sickness in rural districts to a degree corresponding to their reduction in cities. It will come by adapting the efficient city methods to rural conditions.

The environmental conditions in the country are not so favorable as they may seem. The outdoor air is fresh and pure, but country people spend half of their time indoors where the air may be as hot and close as in a city tenement. The sun shines on the fields, but it is often excluded from shaded kitchens and bed rooms. The farm well from which generations have drunk, frequently becomes polluted with household drainage. The rural meeting places are often crowded and

unventilated to a degree that would not be tolerated in New York City. Sewage disposal often consists in the surface exposure of excretions with no protection from flies, vermin, and domestic animals. The environmental conditions in a modern city are often more favorable than they are in the country. The tenement house laws require a certain amount of window space for light and ventilation. The city government prevents overcrowding, requires the ventilation of public meeting places, removes the sewage and garbage, and provides a pure water supply. There is need that many of the environmental conditions in the average rural community shall be raised to the standards which are enforced in cities.

The frequent opportunities for contact of persons with one another increases the likelihood of the transmission of communicable diseases in the city, but it also promotes their control and suppression. The scattered population of rural sections facilitates the concealment of cases. Physicians are called only to grave cases, and there is usually an absence of inspections in homes and schools. Since there is seldom public provision for the care of cases, there is little incentive for them to be reported by the heads of families. The city is in contrast with the country in its personal public health work. Publicity of cases is readily obtained in the city, and their concealment is difficult. The concentration of population makes inspections and visitations easy. Clinics and hospitals provide for their isolation and care, and public health nurses search out the afflicted persons and persuade them to accept treatments. Babies and children in the poorer sections are supervised, and facilities are provided for them to obtain healthful food. The country will exceed the city in healthfulness only when there is a development of both the personal and the environmental branches of public health work.

The standards of efficiency of a rural health department are those of a large city, but the machinery and methods of a city department require considerable modification before they can be applied to a country district. A city health department is highly organized with a commissioner at its head. All phases of its work are handled in a central office, and are administered by specialists and experts who are in frequent communication with the commissioner, and who require daily reports from the subordinates. Practically all health work in a rural community is done by a part-time health officer. Rural health departments are deficient in experts in communicable diseases, in laboratory facilities, and in an engineering staff. These defects may be remedied by the coöperation and supervision of a State department of health, as they are in New York State. The New York plan is that the local department shall exercise primary jurisdiction over its own health affairs, and shall do the detailed work of discovering unsanitary conditions and cases of communicable diseases, and applying the ordinary remedies. The State supplies experts in epidemiology and engineering, and provides laboratory facilities at the call of the health officer. The system fails when the health officer acts only on complaints

and does only what he is compelled to do. It is ideal and satisfactory when the health officer is active in recognizing local needs, and is prompt in reporting impending dangers before they become public scandals.

ORGANIZATION OF A RURAL HEALTH DEPARTMENT.

A rural department of health consists of four groups of persons:

1. The health officer with his assistants, if he has any.
2. The board of health.
3. The practising physicians of the community.
4. Lay organizations which are interested in public health work.

The health officer is the executive officer of the local department of health, and is almost the only official with whom the public comes in contact.

The board of health is the local official body or person to whom the health officer reports, and from whom he receives the authorization for his activities. It controls the law-making, legal and financial branches of local health work.

The practising physicians compose the first line of defense against communicable diseases, and are officials of the department in that they are required to inform the health officer of every case of communicable disease which they see.

Lay organizations, such as village improvement societies, civic clubs, and neighborhood associations, form an essential part of the organization for carrying on local health work. They stimulate and encourage the local officials, and give them moral and financial support.

Sources of Power.—The sources of power of a rural department of health are two in number:

1. Statute laws; and
2. The general desirability of public health work.

The statute laws conferring authority on local departments are usually general in character; and officials may refuse to take a desirable action on the ground that it is not directly authorized by the statute law. But the broader and more usual interpretation of law is that a desirable course of action may be taken if it is not specifically forbidden by a law. Rural health officials are accustomed to base their actions on the ground of necessity or desirability to such an extent that they often forget the legal aspects of their work and try to exercise force for which there is no authority. The actual power of every health official is limited by the statute law as interpreted by the local court; but his authority to persuade and instruct is unlimited and unrestricted. It is an encouraging sign of the times that people generally respond to notices by health officials and that recourse to the police and the courts is seldom necessary.

The Rural Health Officer.—The health officer is the director of all the official public health work within his jurisdiction. The success of local public health work depends upon his knowledge, personality, and character. He is expected to maintain a continuous sanitary

supervision over his territory, and to secure the remedies for the defects which he finds. All complaints affecting public health are referred to him for investigation and action. If a citizen is dissatisfied with his action, the appeal is to the board of health, or to the State department of health.

The qualifications of a health officer are both personal and professional. A health officer must have a pleasant manner, and exercise calm judgment, for the basis of his success is his powers of persuasion and instruction, rather than legal authority. Three types of physicians are undesirable as health officers: (1) the medical politician who seeks the office for money and follows public sentiment instead of leads it; (2) the independent doctor who learned his medicine years ago and who values no one's experience except his own; and (3) the city physician who attempts to apply the laws and methods of procedure of the city to a rural district in which they are not binding. A desirable type of health officer is a general practitioner of medicine who is up to date in his medical knowledge, is public spirited by nature and training, and is respected by his brother physicians and by the general public. An increasing number of men of this type are accepting the position as the scope and duties of the office become clarified and defined, and the legal and police duties are performed by boards of health and other officials to whom they properly belong.

Health officer work is a specialty in medicine, and few physicians are qualified to perform it unless they have had special study and experience. The requirement of New York State is that a health officer must either have taken a special course in public health, or have given satisfactory evidence of special qualifications for the position. The special subjects in which a health officer must obtain proficiency are as follows:

1. Public health laws and procedures.
2. Communicable diseases, their present diagnosis, treatment, and prevention. The standard of knowledge of five years ago is now behind the times.
3. Laboratory methods and procedures, especially methods of taking specimens and the interpretation of the reports.
4. Water analyses and purification, and the supervision of water sheds and sources of supplies.
5. The disposal of sewage and household wastes.
6. Milk inspections.
7. Infant welfare, child hygiene, and inspection of school children.
8. Public health nursing.
9. Methods of publicity and education.

Courses of instruction in all these topics are offered by the University and Bellevue Hospital Medical College in New York City; the Albany Medical School; Syracuse University; University of Buffalo; Harvard Medical School, and the Johns Hopkins University.

Activities.—The office of rural health officer is one of increasing importance and legal responsibility. While he is supposed to be strictly

a health department official, yet duties under other departments are sometimes imposed upon him, probably because he is the most available official to do them. Over two hundred specific duties are imposed upon the health officer by the laws of New York State. Twenty-five distinct duties are imposed by the insanity law, the labor law, the agricultural law, the educational law, and the penal code. Failure to perform any one of the duties prescribed by law may subject the health officer to chrages of inefficiency. A health officer must constantly study the laws and sanitary code in order to perform his duties legally and efficiently.

The public health activities of a rural health officer may be divided into field work and office duties. Field work is along the following lines:

1. Communicable diseases, their control and prevention.
2. Laboratory.
3. Water supplies.
4. Inspection of dairies and their products.
5. Sewage and household wastes.
6. Nuisances.
7. Food sanitation.
8. Sanitation of public buildings.
9. Supervision of public health nurses.
10. Infant welfare, child hygiene, and the medical inspection of school children.
11. Education.

Office work is conducted along the following lines:

1. Records.
2. Reports.
3. Correspondence.
4. Vital statistics.
5. Study of public health subjects.

Communicable disease work includes the following activities:

1. Visitation of reported cases.
2. Searching for unreported cases and investigations into the sources of infection.
3. Instituting and maintaining isolations and quarantines.
4. Taking cultures for diagnosis and release.
5. Assisting family physicians in making diagnosis.
6. Doing intubations, intravenous injections, spinal punctures, and other procedures requiring special skill.
7. Assisting patients to receive medical and hospital treatment.

Laboratory work includes the following activities:

1. Maintaining a supply of diagnostic outfits, and of vaccines and serums from the State department of health.
2. Distributing laboratory supplies to physicians.
3. Taking cultures and specimens and administering vaccines and serums.
4. Receiving and interpreting laboratory reports for physicians and patients.

A health officer may be required to perform the following duties in relation to water supplies:

1. The sanitary inspection of water sheds and sources of supply.
2. Taking samples for laboratory examination.
3. Giving advice regarding the location and construction of a public water supply.
4. Investigating water supplies during an epidemic which may be water borne.
5. Advising private persons regarding their water supplies.
6. Condemning unsafe water supplies.

Dairy inspections include the following duties:

1. Visitation and inspection of dairies, and observation of their operation.
2. Taking samples of milk for laboratory examination.
3. Issuing permits to milk dealers.
4. Giving advice to dairymen and dealers regarding the sanitation of their plants and methods of handling their products.
5. Assisting in securing safe milk supplies for infants and children.
6. Assisting in obtaining tuberculin tests for cattle.

The disposal of sewage and household wastes may require a health officer to perform the following duties:

1. Investigation of complaints regarding improper methods of disposal.
2. Giving advice regarding disposal methods to private parties and to municipalities.
3. Securing public dumping grounds and facilities for garbage disposal.
4. Giving advice regarding the location, construction, and operation of disposal plants.
5. Promoting the formation of sewer districts.
6. The disposal of sewage and garbage during epidemics.
7. The protection of streams and lakes against sewage.
8. The protection of bathing places.

The term *nuisances* includes almost every unsanitary or annoying condition which may affect health, and which is not classed under any other heading. A health officer's activities include the following duties:

1. An investigation of every complaint, and a determination whether or not it affects health.
2. An attempt to secure its abatement by the party maintaining it.

A health officer has the following duties to perform in relation to food sanitation:

1. Investigating all cases of alleged food poisoning, and taking samples of the food for a bacteriological examination.
2. Inspection of places for the sale of foods and drinks, and issuing certificates of inspection to those found sanitary.
3. Advice to the managers regarding the proper methods of handling foods and drinks in restaurants and other places in which foods and drinks are consumed.

The principal buildings which a health officer inspects are school houses, theaters, and public halls. He is to observe especially the following points:

1. Cleanliness.
2. State of repair of the building and rooms.
3. The plumbing and disposal of sewage.
4. The water supply.
5. Overcrowding.
6. Ventilation.

A health officer performs the following duties in infant welfare and child hygiene:

1. The medical inspection of school children.
2. Advice to teachers and parents regarding the correction of the defects which are found.
3. Establishing milk stations and infant welfare centers.
4. The examination of poorly nourished and defective infants.
5. Coöperation with public health nurses and social organizations in promoting the health of children and infants and their mothers.

Educational work includes the following activities:

1. The distribution of circulars of information to those caring for cases of communicable diseases.
2. Giving advice to parents and others who are caring for cases of communicable diseases.
3. Giving information to physicians, nurses, and social workers regarding all phases of public health work in his jurisdiction.
4. Lecturing on public health topics.
5. Giving interviews to reporters and preparing instructive articles for the newspapers.
6. Conducting public health exhibits.
7. Conferences with other officials.

No health officer can do efficient field work unless he is prompt and proficient in his office work. He needs to keep full records in order to produce the detailed information with which to confirm and justify the judgments which he makes and the advice which he gives. He must make public reports in order to convince officials and the public of the efficiency, value, and necessity for public health work in his locality. His influence and reputation will depend largely upon the promptness with which he answers letters and conducts his correspondence. He is expected to be familiar with the records of communicable diseases in his jurisdiction, and with the death-rates and the causes of death in his locality.

The time which a health officer spends in the study of public health topics may rightly be counted as devoted to the discharge of his official duties. The study may be along the following lines:

1. Reading books and periodicals on public health topics.
2. Preparing addresses.
3. Attending educational meetings and clinics.
4. Planning future work.

This brief enumeration of the duties of a rural health officer indicates the scope and importance of his work and the necessity of his having special preparation for the discharge of his duties. He need not be a specialist in any line, but he is expected to recognize a serious condition when it develops, and to be willing and able to procure expert advice and assistance when the condition is beyond his knowledge and experience.

Some of the duties which a rural health officer performs are compulsory, and others are largely optional. The minimum duties which are required are the isolation of reported cases of communicable disease, the investigation of complaints, and the suppression of gross unsanitary conditions and nuisances which are evident to citizens. These duties are chiefly clerical and police, and may be performed by an intelligent layman almost as well as by a trained health officer. A health officer who performs only these duties and acts only on reports and complaints is inefficient and practically useless. The efficient health officer searches for carriers and mild cases of disease, promotes child welfare, and does active educational work. He is a leader and does his work because he wishes to protect and promote the health of the community regardless of what he makes out of the office.

Procedure by the Health Officer.—In some of the activities of a health officer, the persons with whom he deals are subject to legal requirements, and in others their compliance with his advice is voluntary. When his activities affect a person who is subject to the provisions of the public health law or the sanitary code, or to the orders of a board of health, a health officer must follow a certain procedure in order to make his actions legal. He must be particularly careful of the legal aspects of his actions in the isolation and control of cases of communicable disease, in granting or refusing permits, and in suppressing nuisances. The steps which he must take are: (1) investigation; (2) information, and (3) notification.

The first step which a health officer takes is to obtain sufficient evidence to justify his actions if the case should come to court. He will usually obtain the evidence by means of an investigation made by himself or his legal representative. He may also act on the evidence of other persons, but if he does so, his informers might possibly change their statements when they are questioned publicly. If he makes an investigation, his written report will be accepted in court as presumptive evidence of the facts which he states. If a health officer acts without making an investigation or obtaining sufficient evidence, he may be held liable for illegal actions.

The second step is to give to the person who is subject to his control, full information regarding the condition which he finds. If a person does not understand the nature of an unsanitary condition, his ignorance may be taken as an excuse for failure to remedy it.

The third step is to notify the responsible person what he must do to remedy the objectionable condition. He will discuss the matter with the person, and if possible, will come to an understanding with

him regarding the manner and time of carrying out the suggestions and requirements. The notification will usually be verbal, and if a health officer is patient and tactful, mention of legal means or force will seldom have to be made. But if he finds that his suggestions are likely to be ignored, it is his duty to serve them in writing, and to include the statement that failure to comply with them will be followed by legal action against the offender.

A notification by a health officer is popularly called an order; but there are two real distinctions between a notification and an order: (1) the power to issue a legal order lies with the board of health or the State department of health; and (2) a person who disregards a notice given by a health officer, cannot be punished for the act of disobedience; the penalty is for continuing to maintain the condition which menaces health. On the other hand, the act of disobeying or ignoring an order of a board of health is itself a misdemeanor which is punishable. Much of the unpleasantness, unpopularity, and ill-feeling associated with the office of health officer has arisen from the health officer's assumption of the power to give orders on his own initiative. His duty is to inform offenders of the nature of their acts, to instruct them regarding the proper remedy, and to point out to them the consequences of their neglect to comply with his directions. He is neither a police officer nor a prosecuting attorney. If a person fails to heed his directions, the next step which the health officer is to take is to report the matter to the board of health for its action. It is not the duty of the health officer to use force or legal means to enforce compliance with his instructions, unless he is specifically authorized to do so by his board of health. An exception is that public sentiment and the courts will uphold a health officer in placing a police guard to maintain the isolation or quarantine of a case of contagious disease, for this is an emergency in which there is no time for deliberation. Rural boards of health meet infrequently, but a health officer can consult an individual member readily, and can secure an unofficial authorization to take the necessary steps to abate a condition that is a grave menace to health. If he does this, he may feel assured that the board of health will sustain him at its next meeting. The principle involved is that it is not in accord with American ideas of government that any one man alone shall be investigator, judge, and prosecuting officer. Active health officers have often assumed power to give orders because boards of health fail in their duty to consider matters that are brought before them, and to assume their share of responsibility. The coöperation of a board of health with the health officer is necessary in dealing with those persons who defy the health officer. But a health officer has recourse to legal action so seldom that he often forgets the proper method of procedure when force or legal action is necessary.

A health officer is not free from responsibility when he has made a report to the board of health regarding a condition which he is unable to correct. He is still the executive officer in charge of the situation,

and must direct the performance of the action which the board authorizes. This action may be either summary or legal.

Summary action means that the board instructs the health officer to remedy a condition at public expense. For example, it may authorize him to compel the observance of quarantine, to employ persons to cart away a mass of garbage, or to clean an unsanitary cesspool. When summary action is taken, the cost may be recovered from the person who is responsible for the condition.

When the board authorizes a legal action against an offender, the health officer must make affidavits on which the case is founded, obtain evidence, and advise the lawyer who is in charge of the case. He must keep in touch with every phase of the action, and follow up the case to see that the conditions are finally remedied.

Board of Health.—A health officer reports to some official body and is subject to its orders. This governmental body may be a board of health whose members are appointed especially for the purpose, or health matters may come before a board which performs a variety of other duties.

The duties of a board of health may be discussed under five headings: (1) the appointment of a health officer; (2) financial; (3) general policies; (4) legal activities; (5) direct assistance to the health officer.

Appointing a health officer is probably the most important act of a board of health. There are often few physicians or perhaps only one available for the office in a rural section. The law presumes that the board will be able to choose a competent person to fill the position. If no available person is qualified, it is still the duty of the board to appoint an acting health officer until one can qualify.

A board of health has three financial duties to perform: (1) to prepare a budget; (2) to direct the expenditure of the funds; (3) to audit the bills which a health officer incurs.

The items of expenses of a rural health board are usually as follows:

1. Pay of the health officer and his expenses.
2. Pay of nurses and inspectors.
3. Fees of the registrar of vital statistics, and of physicians for making reports.
4. Office rent.
5. Stationery and office supplies.
6. Postage, telephone calls, and messenger service.
7. Maintaining quarantines, and doing disinfecting work in cases of contagious disease.
8. Expressage on laboratory supplies.
9. Suppression of nuisances.
10. Extraordinary expenses during the suppression of epidemics.
11. Educational work, lectures, and exhibits.

The standards of expenditure by rural boards of health vary widely. The law of New York State established the minimum salary of a health officer upon the basis of ten cents for each inhabitant in his jurisdiction. His salary usually amounts to more than all the other expenses com-

bined, and few rural districts spend annually more than twenty-five cents per capita on public health work. This is less than half the rate of expenditure in the larger and more progressive cities.

The general lines of public health work in a community are largely determined by the board of health, partly by its financial appropriations and partly by its support of the health officer in his activities which do not require the expenditure of money. If it is generally known that a board of health is active in its support of the health officer, people will give heed to his suggestions.

The source of authority for the acts of a board of health is the statute law. Some laws require a board to perform specific duties; others permit a board to do certain things; still other laws are general and their broad interpretation allows a board to do almost anything reasonable to promote public health. For example the law of New York State prescribes that a board of health must control persons afflicted with contagious diseases; it permits boards to engage in anti-mosquito work; and a few boards conduct exhibits and lectures under a broad interpretation of the section giving them authority to direct the health officers in the performance of their duties. A board of health is usually willing to perform the duties required by law; but they are not always willing to engage in new or unusual lines of work except in response to public sentiment. The usual methods of obtaining action by a board of health is to conduct a campaign of education in order to arouse a public demand for the activity. A health officer may conduct any line of work which is merely advisory and educational and in which the people's compliance to his suggestions is voluntary; but he cannot compel obedience to his suggestions unless the board specifically authorizes this action.

A rural board of health has authority to conduct legal work along three lines: (1) the adoption of a local sanitary code; (2) issuing special orders; (3) authorizing and conducting prosecutions against offenders.

The statute laws are usually general in their nature and application. Local boards of health have authority to enact a sanitary code whose regulations deal with the details of the application of the statute law. For example the public health law of New York State requires a local board to guard against the introduction of infectious diseases; but a local board may prescribe the manner of establishing a quarantine, the length of time of an isolation period, and the method of disinfecting the sick rooms. A local sanitary code usually deals with subjects with which a health officer has to deal frequently. The following are among the subjects which local health ordinances usually cover:

Communicable diseases.
Dairy regulations.
Food sanitation.
Disposal of household wastes.
Cesspool construction and cleaning.
Privy construction and management.

Disposal of stable manure.
Suppression of flies and mosquitoes.
Pig pens and chicken yards.
Slaughter houses.
Smoke.
Unnecessary noises.
Spitting.

A sanitary code greatly simplifies the work of a health officer. The fact that a condition is a violation of the sanitary code is sufficient to condemn it and to subject the violator to a penalty. A sanitary code has the effect of an order to the health officer that certain conditions are to be considered detrimental to health and to be subject to his control. If an unsanitary condition or nuisance develops which is not covered by the sanitary code, a health officer must prove not only that it exists but also that it is detrimental to health. It is the duty of every board of health to enact a sanitary code.

The power of a local board of health to enact a sanitary code is unquestioned in the courts. The principle of home rule and control prevails in health matters as in other branches of governmental activities, provided that no regulation conflicts with a statute law or other provision made by a higher authority.

When an unsanitary condition is not covered by a specific provision of the law or sanitary code, a board of health may investigate it and issue a special order for its correction. This order is a special regulation made for that case only. It has the effect of the sanitary code, with the additional force that it deals with a definite condition that is already developed, and that it is directed to one person. It has the same legal standing as a court order.

The full legal proceedings in issuing an order are as follows:

1. The matter shall be considered at a meeting of the board of health. If the members have personal knowledge of the condition, they may make their decision without an investigation or hearing. The board may conduct a formal hearing, and for that purpose it has the power of a local court in summoning witnesses and taking testimony.

2. The decision and order shall be entered in the minutes of the board.

3. The order shall be served upon the offender, and a copy of it, together with an affidavit of service by the serving officer, shall be filed with the board.

If an order is disregarded or disobeyed the next step is to begin legal proceedings against the offender. The proceedings may be an arrest upon criminal charges of disobedience, or a civil action for the collection of a penalty for maintaining a condition that is detrimental to health.

One of the duties of a board of health is to authorize and conduct prosecutions for violations of the sanitary code or for maintaining unsanitary conditions after the health officer has been unsuccessful in his efforts to remedy the condition. The proper agent of the board is not the health officer but a lawyer employed for the purpose. A court

action is a last resort and is seldom instituted in rural districts, for it is usually difficult to obtain a conviction when all the parties at court know one another intimately. Effective results can nearly always be obtained by making publicity of investigations and calling the attention of offenders to their liability to a fine or penalty.

A board of health may often be of great direct assistance to a health officer if each member will be ready to visit persistent offenders with the health officer. Many persons refuse to obey a health officer because they believe him to be vindictive and malicious. A member of the board can act as a peacemaker and instructor, and his presence will often settle a matter which no health officer alone could handle. The fact that the board of health is supporting the health officer is usually sufficient to bring offenders to terms.

The Physician and the Health Department.—Medical service is usually considered to be a private matter, to be chosen and bought like clothes, and accepted or rejected according to the personal desires of the individual. The practice of medicine is conducted along two general lines, (1) curative and (2) preventive. Family physicians practice curative medicine and do little preventive work. They are dependent for their living upon those who hire them. They are the servants of their patients and must render the service for which they are paid. People call a physician to cure them of a sickness that has already developed, but they are seldom willing to pay a physician to advise them how to keep well and vigorous and to avoid conditions which may be dangerous to health.

Preventive medicine is conducted along two lines: (1) personal and (2) social. Personal preventive work consists largely in performing such duties as taking precautions for the protection of other persons, reforming unhygienic personal habits, and accepting vaccines against diseases which are not existing in a given locality. These activities are unpopular, and a private practitioner cannot be expected to make them a prominent part of his work. The majority of people have no control over many unhealthful conditions amid which they live and work, and it would be futile for them to employ private physicians for advice along these lines. Over half of the activities of a practitioner of preventive medicine are conducted along such lines as public water supplies, milk inspections, public sewage disposal, housing, recreation, and conditions in industrial establishments. The control of these matters is not within the scope of the duties of a private practitioner of medicine, but it belongs to specialists in departments of health. Private practitioners of medicine are inexperienced and untrained along most preventive lines of work, and will remain so until the people become educated to demand that their medical advisors shall be responsible for preventive work. But general practitioners of medicine are not entirely free from responsibility in preventive medicine, for they have definite duties to perform under the public health laws, particularly those relating to communicable diseases and vital statistics.

Reporting cases of communicable diseases is universally recognized

as the duty of a physician. The New York State Public Health Law, Section 25, requires a physician to make a report to the health officer concerning every case of certain communicable diseases which he attends. The New York State Sanitary Code, Chapter 2, Regulation 2, requires the report to be made within twenty-four hours after the case is first seen, and immediately if it is on a dairy farm. The effect of these legal requirements is to make the physicians of a community an integral part of a department of health. Every physician is an official diagnostician for his local department, and the legal standing of his report is the same as that of a report made by a health officer. The report is the ground which justifies a health officer in taking official action for preventing the spread of the disease. A report made by a physician is not a violation of his confidential relations to his patients.

The diseases which a physician must report are specified by the State department of health. Practically all departments of health require the reporting of such well-known diseases as smallpox, typhoid fever, and scarlet fever. There are twenty-eight diseases on the list in New York State.

Cases of communicable diseases may be divided into three classes: (1) those which are plainly evident; (2) those which are mild or have only suspicious signs; (3) carriers. The evident cases present no difficulties to a family physician, but he is often in doubt in regard to suspicious cases and carriers. It is the intention of the law that a physician shall make a diagnosis promptly in every case to which he is called, and that he shall use every available means of making a diagnosis. The New York State Sanitary Code, Chapter 2, Regulation 10, requires a physician to take cultures from the throats of persons in whom there is reason to suspect the existence of diphtheria. The attitude of physicians toward reporting suspicious cases and carriers depends to a great extent upon the health officer. The larger cities meet this difficulty by employing disinterested experts as official diagnosticians. A rural health officer is usually the only health official that is immediately available. If he is an ignorant bluffer, he may get the family physician into personal difficulties with the patient. If he belongs to the rubber-stamp variety, he will simply agree with the doctor, and the result will be that the responsibility is placed entirely upon the family physician. The exact scope of duty of the health officer is not defined, but it is reasonable that he should be held responsible for the diagnosis of a suspicious case which is reported to him by a physician. There is seldom any difficulty between a physician and a health officer when the health officer is competent and is willing to assume his proper share of responsibility.

The state departments of health of many of the states assist family physicians in making diagnoses by examining specimens and cultures sent to the laboratories by physicians. The Department of Health of New York State provides the mailing outfits for the specimens. It also sends expert diagnosticians at the request of local health officers.

The question often arises in rural communities whether or not the

health officer shall examine every case that is reported to him. It would be ideal if he should personally see every case, but a family physician has good grounds for objecting to the visits of a health officer who is dishonest, or ignorant, or untactful.

An active health officer who is a competent diagnostician will be disquieting to a rural physician who has been accustomed to independence in action and expression, who ceased to study years ago, and who diagnoses respiratory diseases as colds, typhoid fever as indigestion, and meningitis as nervousness. But departments of health are raising the standards of the practice of health. They constitute almost the only power that compels physicians to study and to keep up with the times.

Physicians are expected to protect the public against the spread of communicable diseases. The duty is legally recognized in the Sanitary Code of New York State, Chapter 2, Regulations 11, 16, and 17, which require a physician to take measures for the isolation of his patients who have communicable diseases, and for the proper disposal or disinfection of their excretions. Many physicians shirk this responsibility on the ground that it is not their duty to place restrictions on their patients for the benefit of other persons. Other physicians object to the visits of a health officer and then fail to carry out the isolation and disinfection. A great deal of the difficulty and unpleasantness connected with isolations and disinfections may be avoided by the use of official circulars of information, such as are issued by the New York State Department of Health, giving a uniform method of procedure for each disease. If one of these circulars is left with each case of communicable disease, both the physician and the health officer and the head of the afflicted family can readily come to an agreement regarding the management of the case.

The removal of restrictions upon a family is not the privilege of a physician. Instituting an isolation or quarantine is a legal action and the health officer is the only person to terminate the period legally. It frequently lasts for a period much longer than that of the visits of the physician. A health officer will usually accept the family physician's statement that the patient may be released, but in case of doubt he may properly require the physician to give a written statement that the patient cannot give the disease to another. This statement is equivalent to saying that a patient is not a carrier, and a physician will seldom give it unless he has complied fully with all legal and scientific requirements.

The departments of health of many states provide antitoxins, serums, and vaccines for the prevention or treatment of many diseases. Physicians sometimes refuse to make use of them on the ground that they do not believe in them. Such statements are confessions of ignorance. The preparations represent standard and approved methods of dealing with the diseases with which they are associated. If a physician fails to make use of them in a case in which recovery is unsatisfactory, there is a strong presumption that he is guilty of neglect.

Physicians have a public duty to perform in instructing their tuberculosis patients in the measures for preventing the spread of the disease. The laws of New York State require every physician to exercise efficient supervision over his tuberculosis cases, but the laws also provide that he may be relieved of that responsibility if in reporting a case he is unable or unwilling to assume the duty. The supervision then devolves upon the health officer or upon the public health nurse if there is one.

Physicians are required to issue certificates of death and to report the births which they attend. These duties are often irksome, particularly when the physician must make a considerable effort to ascertain such details as ages, occupations, and the names of parents. But the importance of the records justifies the law that each physician shall report his cases in all the required details.

Physicians sometimes feel that departments of health are encroaching upon their prerogatives and practice in making provision for expert consultations and for free treatments. This criticism in New York is made particularly in regard to tuberculosis, venereal diseases, and poliomyelitis. The State Department of Health has assumed a certain amount of supervision over these cases because physicians generally avoid them. A canvass of rural section in campaigns for establishing tuberculosis hospitals shows that over half of the advanced cases of tuberculosis have no physician regularly in attendance, and the examination of men drafted for the national army show that not 10 per cent. of the incipient cases have been told by any physician that they have the disease. A canvass of physicians in one large section of New York shows that a large proportion of the leading physicians refuse to treat venereal diseases. When the number of cases of venereal diseases in drafted men entering the army cantonments is compared with the number under treatment by physicians, it is found that very few are receiving treatment except possibly for a few days during the acute stage. The experience in the State clinics for the care of paralytic and weakened conditions following poliomyelitis demonstrates that most physicians consider the cases to be a burden and are anxious for the State to assume their oversight and care. Since physicians have generally neglected these diseases, the people are not accustomed to consult their medical advisors regarding them. The State department of health is educating people in the need of seeking medical advice for these conditions and of taking it until they are not only able to go to work but are also free from disease germs and physical evidences of disease. It would be to the personal advantage of physicians if they would coöperate in this educational work, would become proficient in the diagnosis and treatment of the conditions and would seek to treat the cases instead of to avoid them. It is not the policy of a department of health to make provision for giving advice and treatments which individuals can secure for themselves. The policy of the departments is to place their facilities at the disposal of all physicians who are willing and desirous to retain control of their patients and to encourage people to seek advice from their own private doctors.

The duties which a department of health requires of a physician are no more than a conscientious physician would observe for the protection of his patients and the public. The services which an efficient department of health renders to a physician far outweigh the slight inconvenience which it imposes upon him in complying with its requirements. A rural physician in New York State receives direct benefit from the following activities of the State health department.

1. Providing culture tubes and other diagnostic outfits and mailing cases for sending them to the laboratory.
2. Examining specimens and reporting the findings to the physician.
3. Providing experts to diagnose obscure and unusual cases of contagious disease, and to obtain laboratory specimens and administer treatments by the more difficult procedures such as spinal punctures and drawing blood.
4. Providing epidemiologists and public health nurses to investigate the causes of an outbreak of a communicable disease.
5. Providing vaccines and serums for treating the sick and immunizing the well.
6. Providing muscle trainers to supervise the care of crippled children, especially those suffering from poliomyelitis.
7. Conducting clinics for assisting physicians in giving advice and treatment to cases of tuberculosis, venereal diseases, and poliomyelitis.
8. Supplying instructive pamphlets to be given to cases of contagious diseases.
9. Instructing physicians in diagnosis, treatment, and other subjects which are of direct value to them in their daily practice.
10. Calling the attention of patients to conditions of which they were not aware and directing them to physicians for advice and treatment.

Lay Societies.—Lay societies often take an active interest in public health and are recognized as unofficial parts of departments of health. The list of such societies includes boards of trade, granges, civic clubs, village improvement societies, mothers' clubs, and parent teachers' associations. A health officer can usually find an organization that will support his work and promote its enlargement. The history of nearly every public health movement that is successful is that it is considered at first by only a few individuals, is then promoted and financed by an organization or society, and finally when its need and success is demonstrated, it is assumed by a board of health and conducted at public expense. An efficient health officer will work in harmony with the societies in his jurisdiction. He will instruct them in the needs of his district, advise them regarding plans of action, and assist them in campaigns of education. The efficiency of public health work in a rural community will depend largely upon the existence of a local organization composed of public-spirited citizens.

The public health activities that are usually promoted by lay organizations are as follows:

1. Public health nursing.

2. Forming a sewage district.
3. Conducting the collection of garbage.
4. Promoting pure milk.
5. Food sanitation.
6. Organizing clean-up campaigns.
7. Anti-fly and anti-mosquito work.
8. The examination of school children, and the correction of their defects.
9. Infant welfare work and milk stations.
10. The care of crippled children.
11. Anti-tuberculosis work.

Inspectors.—The assistants which a rural health officer will need as his work increases are an inspector and a public health nurse. The inspector will look after environmental conditions outside of homes, such as sewage disposal and nuisances, while the nurse will do personal work within the homes.

The essential qualifications of an inspector are that he be an intelligent, sensible, honest man who is observant, is able to make a clear report upon what he sees, and is not given to talking and making threats. He need not be educated or trained in technical work. A type of person who makes a good inspector is the one who is in demand as a man of all work. He will usually be able to suggest a practical remedy for the insanitary conditions which he finds. His legal standing will be that of agent of the health officer. He will have a right of access to private property, and the legal standing of his reports will be that of the report of the health officer.

The activities which an inspector will usually carry on are as follows:

1. The construction and maintenance of fly-tight, sanitary privies.
2. The disposal of dead animals, garbage, manure, and other substances that are subject to decay.
3. The prevention of the pollution of streams and lakes.
4. Cesspools and sewage disposal.
5. The elimination of the breeding places of flies and mosquitoes.
6. The supervision of quarantined premises.
7. Disinfections and renovations after the termination of cases of communicable diseases.
8. Follow-up work after inspections made by the health officer.
9. The inspection and suppression of nuisances.

PUBLIC HEALTH NURSING.

The original work of a health officer was to control epidemics and suppress nuisances, and he dealt with those conditions only when they were evidently dangerous or directly annoying. The work has now been extended to include the prevention of diseases, the correction of remediable defects and the promotion of hygienic habits of living. The newer public health work teaches parents to care for their babies, and to

bring up their children in correct habits of diet, play, work, and rest. It supervises the mode of life of adults who are subject to tuberculosis and other weakening diseases. It consists largely in the personal education of individuals, especially mothers. Parents and householders with financial means seek advice from their family physicians, but about one-quarter of all the people cannot afford to buy the services of a physician except for cases of disabling sickness. These people go unadvised and unled in health matters unless the department of health reaches them. The promotion of all phases of preventive medicine is one of the recognized duties of a rural health department. The health officer cannot spend the time to do this work, and if he could, he would not be fitted for it. This work belongs to a public health nurse. Every community of 3000 people will find abundant work for a full-time public health nurse.

The public health nurse is the field agent of the health officer. She spends most of her time visiting in private homes. She recognizes defects and unhygienic habits, brings children and patients to physicians or clinics for examination, and makes the arrangements for their correction and treatment. Physicians are nearly always willing to give medical advice and surgical treatment provided some one assumes the burden of explaining the nature of the diseases and defects and makes the arrangements to carry out treatments effectively. The public health nurse may have to spend an hour or two persuading and instructing a parent to submit her child to an examination or operation which takes only a few minutes of a doctor's time. She makes it possible for people in moderate financial circumstances to receive the benefit of medical and surgical advice which may prevent a severe attack of sickness or may enable a patient to return to a useful occupation. She is a teacher of the newer phases of public health work and brings a knowledge of the possibilities of preventive and corrective work to those who would otherwise remain ignorant and would become weaklings because the means of help were not brought to their attention.

Charitable organizations often support visiting nurses to do bedside nursing for those who are actually sick. This work is not to be confused with that done by a public health nurse employed by a department of health. A visiting nurse goes where she is called by physicians. She spends her time nursing a few cases, and she can see only a few in a day. Her work usually ceases when the patient no longer requires the visits of the physician. In contrast with her work a public health nurse does little bedside nursing herself. She may instruct a householder how to care for a patient or she may assist in securing a bedside nurse; but her peculiar work is to instruct people how to prevent sickness and how to promote greater vigor and strength in those who are only slightly below standard in health. There is a field for both a visiting nurse and a public health nurse in a community, but the two activities cannot be combined in one person, for when they are, the care of a few bed cases monopolizes the entire time of the nurse.

The activities of a rural public health nurse are usually conducted along the following lines:

1. Suppressing epidemics.
2. Anti-tuberculosis work.
3. Infant welfare.
4. The inspection of school children.
5. Child hygiene.
6. General inspections.

A nurse will render valuable assistance to a health officer in searching for cases of communicable disease to which no physicians are called. She will discover mild and missed cases of the more severe diseases, such as scarlet fever and diphtheria. If an epidemic of disease breaks out, she will make a house to house canvass, instructing parents in the signs of the disease, the methods of isolation, and the means of preventing the spread of the disease. She is especially valuable in the control of the minor diseases, such as mumps, German measles, and chickenpox. A great value of her work is that she educates parents in the need of isolating their children when they have a mild sickness of an undetermined nature.

Anti-tuberculosis work is not effective unless there is a visiting nurse to supervise the cases. The nurse is especially valuable in instructing patients during the pretubercular stage of the disease. She can combat an unreasoning fear of consumption and can popularize a free discussion of the disease. She can demonstrate the curability of the disease and promote a knowledge of its true nature and of the usual history of a case. She can supervise the advanced cases, secure medical or sanatorium treatment for them, and instruct their families in precautionary measures.

The greatest saving of life during the last twenty-five years has been among children under five years of age, and has been accomplished largely by means of public health nurses. The nurses visit and instruct mothers in their homes, conduct classes for mothers and older sisters, establish milk stations, and promote a sanitary milk supply. Infant welfare is one of the most important phases of the work of a public health nurse.

A broad field of usefulness of a public health nurse is the discovery, prevention, and correction of defects which prevent the physical and mental development of children. These defects may be discovered by a medical inspection of school children. The formal examinations are made by the school physician, but securing the correction of the defects is the work of the public health nurse and will seldom be done unless a nurse is employed. The discovery and correction of defects and the control of the conditions which produce them are included in the general subject of child hygiene. These varied activities in a rural community will be conducted by a public health nurse. Examples of the conditions which she will investigate and treat are defective sight and vision, paralyses, poor nutrition, tuberculosis, adenoids and tonsils, and mental deficiency.

A public health nurse will make inspections of places for the sale of foods and drinks, and of schools, theaters and other meeting places. She will report the unsanitary conditions which she may observe on her rounds of duty.

Public health nursing is universally recognized as necessary in large cities, but its need is not always felt in rural places. The usual method of starting the work is to arouse the interest of an organization or committee that will raise the money to employ a nurse for a brief period with the expectation that if the work is successful, it will be continued as a governmental activity. Advantage may be taken of an epidemic to urge a board of health to employ a nurse to canvass the houses and schools for the discovery of cases. She will discover many defects among children and conditions that require attention, and her report may be used as a basis for urging the permanent employment of a public health nurse.

The public schools afford an excellent field of work for a rural public health nurse and are especially valuable in starting the work. Defects begin to show their bad results when a child is compared with others in school and the nurse can use the observations and the reports of the teachers in approaching the parents at home and persuading them to allow the correction of their children's defects. The nurse will also be enabled to reach the younger children and the babies, and she will cover her whole field of service through the schools.

Public health nursing in the country differs from the work in the large cities in that the rural nurse has no fixed schedule of duties and can seldom lay out her work for many days in advance; but she must hold herself ready for any phase of the work as it develops. An efficient nurse makes her own schedule and engagements and adapts herself to her district. Work in rural sections appeals to many public health nurses because of its varied nature, its freedom, and its independence from rigid discipline. A conscientious nurse will regard the freedom and liberty of action as a responsibility which is to be met with her best efforts. Rural public health nursing has been amply justified wherever it has been properly managed, and its extension will be the next great development in rural public health work.

PUBLIC HEALTH LABORATORY.

The practice of modern medicine is impossible without a laboratory. Physicians were formerly guided by clinical observation only. Physical examinations have been used scarcely a hundred years and bacteriology has developed within the memory of physicians who are still in active practice. Clinical observations, physical examinations, and laboratory analyses form a trinity of diagnostic methods, each of which is necessary and none of which is complete in itself. Every physician can employ the method of clinical observation and physical examination, but only a few have special skill and experience for doing labora-

tory work. Small communities cannot afford to maintain their own local laboratories. New York State provides the laboratories at the expense of either the counties or the State. It is one of the necessary activities of a State department of health to supply the laboratory needs of rural communities. It is equally the duty of physicians to make use of the laboratory for the benefit of their patients, the public, and themselves. The health officers of New York State are the agents of the laboratories of the State Department of Health, for they maintain supplies of culture tubes, vaccines, serums, and other laboratory material, and give them to physicians on request. They also assist physicians in obtaining specimens and in giving vaccines and serums.

The activities of a public health laboratory are usually confined to diseases which are communicable and conditions which have a direct bearing upon public health. The laboratory activities which are conducted in rural districts are as follows:

1. The examination of cultures and specimens derived from the human body for the purpose of detecting bacteria of disease.
2. The examination of sewage for disease germs and decaying matter, chiefly to determine the degree of its purification.
3. The examination of water for its purity and the presence of substances of human origin.
4. The examination of milk for bacteria as an indication of its freshness and wholesomeness.
5. Giving advice regarding remedies for the conditions which are found.
6. Preparing vaccines, serums, and antitoxins for the prevention and cure of disease.

There are twenty-eight reportable diseases in New York State and the laboratory is of direct assistance for diagnosis or prevention or treatment in all except six—chicken-pox, German measles, measles, mumps, scarlet fever, and trachoma. A diagnosis of all the others except poliomyelitis and smallpox may be made by finding their special disease germs in the excretions or blood.

Curative serums are prepared for anthrax, cholera, diphtheria, dysentery, epidemic cerebrospinal meningitis, gonorrhea, plague, pneumonia, and poliomyelitis. Vaccines or other similar substances for prevention or cure are prepared for cholera, diphtheria, dysentery, paratyphoid fever, plague, rabies, smallpox, typhoid fever, and whooping-cough.

Bacteriological examinations are extremely sensitive methods of detecting disease germs, and the question often arises regarding the meaning of the laboratory reports when the bacteria produce no perceptible effects. There is danger on the one hand of arousing an unreasoning fear of all bacteria, and, on the other, of minimizing the necessity of all precautions, since a person may be healthy and still harbor bacteria which are virulent to others. Carriers are detected only by means of a laboratory examination, and their control is often peculiarly difficult in rural districts where the subject is new to the

people and is seldom mentioned in newspapers and periodicals. Each report must be considered by itself and the case to which it applies must be handled after a full consideration of all phases of the question.

PUBLICITY AND EDUCATION.

Success in public health work depends on the coöperation of the people and on their knowledge of the methods and objects of the activities of departments of health. Stubbornness and hostility are usually due to ignorance and are overcome by education. The health departments of the several States and of the larger cities carry on extensive work in publicity and education. The promotion of this work is especially important in the country owing to the absence of the educational advantages of the city. People are naturally about a generation behind advanced public health workers in their knowledge of modern medical subjects. One of the great objects in public health education is to make the knowledge of modern sanitary methods and discoveries immediately available to the general public.

People usually get their knowledge of public health matters largely from tradition. They call every kind of infection a cold after the manner of their fathers, and believe in the efficacy of a change of air for the most varied ills. These old notions are often confirmed by physicians, especially those who ended their study of medicine when they graduated from college. People get sanitary and hygienic ideas from newspaper articles which are planned from the standpoint of news rather than of medicine, and are often written by editors who know hygiene as slightly as their re ders. Instruction is given in sanitation in public schools, but the teachers themselves are years behind the advanced knowledge of physicians. The reports and publications of departments of health are also popular sources of knowledge in hygiene. But in addition to all these means departments of health must do educational advertising which will influence the people to vote taxes for the support of public health work. "Public health is purchasable" is the motto of the New York State Department of Health. Whether or not people will place a money value upon health will depend largely upon their knowledge of the accomplishments and aims of the departments of health.

The methods which a rural department of health may adopt in its publicity and educational work are:

1. Private explanations by the health officer.
2. Newspaper publicity.
3. Formal reports.
4. Lectures.
5. Posters and handbills.
6. Exhibits.
7. Campaigns for special objects.

The most effective educational work is that done by the health officer himself in the discharge of his official duties. Every case of communi-

cable disease which he isolates affords an opportunity to instruct the whole household regarding the nature of the disease, the precautions to take, and the methods of its isolation. Every complaint which he investigates or nuisance that he inspects is a subject for a short talk on its sanitary bearing. The audience will be far larger than those who actually hear him, for his words will be quoted to the neighbors and his ideas will be favorite topics for discussion in the whole neighborhood for days afterward. The advantage of this method of imparting knowledge is that the subject is something in which the people are vitally and immediately interested. A health officer neglects one of the greatest of his opportunities if he fails to take time to instruct the persons whom he seeks to control.

A second method of reaching the people is by means of the country newspapers. A rural paper reaches practically every person in a township and every personal item is noted. Health officers and public health nurses are usually modest in talking and avoid personal advertising, but they are also public officials and have a duty to inform the people regarding public health affairs just as a private physician is expected to inform the family regarding a sick patient. An efficient health officer will be a standard source of news for an editor, and in return the editor will be disposed to give publicity to the plans of the health officer and to support his policies. A health officer may properly give to a reporter accounts of the work which he does, interviews on timely subjects, articles of information on matters before the people, and the formal reports which he makes to his board of health.

One reason that the people often do not realize the importance of public health work is that the health officer does not take the trouble to make written reports to his board of health. The fact that a report is in writing makes it available as an educational document. The confidence which the people feel in a department of health depends largely on the formal reports which reach them.

Lectures on public health topics are also of great value in instructing the people. Societies and organizations are often anxious to promote lectures on a subject which is popular and timely, and the services of well-known lecturers can usually be obtained from the departments of health of the cities and States.

Posters and handbills are valuable in informing the people regarding matters of immediate interest to the people. They can usually be distributed to every home by means of school children.

Exhibits are often sent out by State departments of health and philanthropic societies. They usually consist of charts, lantern slides, moving-picture films, and apparatus used in public health work, and may be obtained for a few days at a time.

Campaigns are often conducted to secure special objects, such as the formation of a sewer district, the establishment of an infant welfare station, or the employment of a public health nurse. A campaign usually includes all the methods of publicity and education that have already been mentioned.

It is important that an explanation, or a newspaper article, or a speech shall be given in words that the people can understand. Technical words such as physicians use among themselves are almost meaningless to the public and have no appeal even when the people are educated in other matters. But when public health is presented in simple words, its meaning may be grasped without effort and the thought readily sinks into the minds of the readers or hearers.

RECORDS AND REPORTS.

One of the sources of weakness of a rural health department is usually the meagerness of its records. A health officer can usually do his field work without keeping records or making formal reports. He usually has few items in any one line of work and can readily carry them in mind until the work is accomplished. Yet if each item were recorded as is done by officials in a city or State department of health, the total would probably surprise the health officer and the public.

Records and reports are necessary in order to inform the public of the work of the health officer and to arouse the interest of the people in public health matters. They are absolutely necessary in order to enable a board of health to form an intelligent budget. They are also extremely desirable on account of their effect on the health officer himself. They compel a health officer to state the problems which come before him and to see himself as others seen him. A problem clearly stated is half solved. Many things which at first seem important and annoying are seen to have no foundation when they are described, and many that seem trivial assume importance when they are considered in writing.

The records and reports which a rural health officer may profitably make are as follows:

1. A diary.
2. A note book.
3. A permanent record book.
4. Reports on special work.
5. Regular reports, monthly or annual.

Records of field work are necessary for the protection of the health officer himself and of the municipality which he represents. If the legality of his acts should be questioned and he should be compelled to defend himself in court, his written records will be the most valuable evidence that he can present. The New York State law is that the records are presumptive evidence of the facts to which they relate. (Public Health Law, Section 21-b.)

A diary would correspond to the daily visiting list of a physician and would be evidence of the dates of his visits and inspections. A health officer could use the diaries on the witness stand to refresh his memory even if the entries are meager and are meaningless to other persons.

A note-book would contain brief outlines of inspections, descriptions

of unsanitary conditions, and histories of cases of contagious diseases. Notes made while a health officer is making an inspection are the strongest kind of evidence that he can present. A note-book would correspond to a day-book of a shopkeeper.

The Department of Health of New York State has devised a permanent record book for the use of health officers. It contains pages for the following records:

Communicable diseases.
Complaints and nuisances.
Registration of deaths without medical attendance.
Commitments for insanity.
Inspections of public buildings.
Milk dealers' permits.
Expenses.
Supplies received and delivered.
Miscellaneous.

When a health officer makes a special investigation of an epidemic or complaint or other condition, it is his duty to make a written report of his findings to the board of health or other authoritative body. A standard form of report contains the following items in the order given:

1. Name the condition under investigation and state the particular reason for making it.
2. State specifically the time and place of making the investigation and name the persons consulted.
3. Describe the conditions that were found. Include names, addresses, dates, and accurate figures if possible.
4. State the advice which was given and the official action taken.
5. State the attitude of the person responsible for the condition and the likelihood of his compliance with the directions that were given.

The object of the report is to give a complete description of the condition, so that a board of health or court may readily understand its nature and the official action that was taken.

The regular reports of a health officer may be compiled from the permanent record book, if one is kept. A monthly report will be principally statistical. The form used by the State Department of Health of New York contains the following items.

1. Communicable diseases.
2. Special conferences attended.
3. Hours devoted to health matters.
4. Amount of money audited by the board of health.
5. Public buildings inspected.
6. Premises cleaned, renovated, disinfected.
7. Dairies scored.
8. Permits issued.
9. Lectures given.
10. Board of health meetings attended.
11. Complaints received, investigated, satisfied.
12. Sanitary inspections made.

13. Laboratory supplies issued.
14. Other items of work.
15. Remarks and explanations.

An annual report will be both statistical and descriptive, and will include a discussion of the following items:

1. Communicable diseases.
2. Vital statistics, especially deaths and births.
3. Complaints and nuisances.
4. Dairy inspections.
5. Water supplies.
6. Sewage disposal.
7. Garbage disposal.
8. Suppression of flies and mosquitoes.
9. Midwives.
10. Public health nursing, including child hygiene and infant welfare.
11. Anti-tuberculosis work.
12. Laboratory supplies.
13. Educational work, lectures, newspaper articles, and exhibits.
14. Expenses and budget.
15. Lay organizations coöperating with the health officer.
16. A plan for the coming year, especially a specific object on which special stress will be laid.

SANITARY SURVEY.

A health officer is expected to be familiar with the sanitary conditions in his district. A form for a sanitary survey required by the New York State Department of Health contains the following items:

1. Population, total; by age; by race; foreign born.
2. Topography, soil; natural waters.
3. Financial expenditures.
4. Water supply; sources; purity; records of analysis; recommendations made by State Department of Health.
5. Sewage disposal; sewage districts; sewage connections; cesspools; privies; relation to wells.
6. Disposal of other wastes; garbage; manure. Local ordinances regarding them.
7. Nuisances; the nature of the principal ones; factory wastes.
8. Public streets; accidents at railroad crossings.
9. Buildings; tenement houses; building regulations; bath rooms; public buildings inspected regularly.
10. Schools, number; special provision for tubercular children; medical inspection of babies.
11. Hospitals; provision for general cases; for contagious diseases; for tuberculosis.
12. Labor camps; their number and character; sanitary condition; permits issued.

13. Summer resorts; inspections made; provision for milk; waste disposal; sewage disposal.

14. Barber shops; their sanitary condition.

15. Dairies; number; average score; licensing; general character of milk supply.

16. Special sanitary code regulations (common towels, common drinking cups, spitting, midwives, etc.).

17. Educational work; lectures; number of people reached; conferences attended by health officer; other educational work.

18. Miscellaneous (board meetings, hours devoted to public health work; assistants; annual reports; lay societies assisting the health officer; record book; tuberculosis register.

19. Conclusions; special needs of the district (public health nurse, other assistants; more money; laboratory facilities; coöperation from the board of health; pure water supply; sewage system; educational work; improved milk supply, etc.).

STATUS OF A RURAL HEALTH OFFICER.

A health officer is the medical advisor of a municipality and his relation to a community is the same as that of a trusted physician to a family. He is an all-round practitioner of public health medicine and his standing with experts will depend upon the same personal factors that determine the reputation of a family physician with specialists in medicine and surgery. Hundreds of rural health officers are doing a high grade of work which merits the confidence of the best experts in the departments of health of States and large cities. Health officer work is becoming standardized and ennobled, and its practice is a worthy ambition for the best medical talent in a community.

CHAPTER XXIII.

TROPICAL HYGIENE.

By M. E. CONNOR, M.D.

CLIMATE.

Meteorology treats of climate and weather.

Climate may be tropical, semitropical, temperate, mountain or marine and is dependent in the main upon (1) distance from the equator, (2) height above sea-level, (3) distance from the sea, (4) direction of prevailing winds. The tropical climate is one of constant high temperature, relative humidity, intensity of light, increased electric tension and actinic action of the sun. A climate cannot be considered unhealthy because of high temperature alone, the relative humidity is the important factor in preventing the white race in adaptation to tropical environments.

Weather, is a term to designate the condition of the atmosphere with reference to wind, pressure, temperature, water-vapor as humidity, clouds, precipitation and evaporation, electricity.

Temperature.—Climate and temperature are largely controlled by the water-vapor in the air, rainfall, distance from ocean currents, altitude, movement of air and the presence or absence of vegetation. Coast areas will have a more equable temperature than inland localities. The body temperature is regulated by an nervous mechanism and the temperature is prevented from rising through the dissipation of excess heat by sweating and by radiation, conduction and convection.

Air is a mixture of the gases, O and N, water and varying amounts of carbonic acid gas and a small amount of solid matter. The body needs all the air it can get, especially in the tropics there is never any danger of receiving too much air into the body. Modern medicine strongly urges open-air treatment in diseased lungs and certain other ailments.

Air is rendered impure by:

1. Products of respiration	carbonic acid. dead tissue. bacteria
2. Products of decomposition	hydrogen sulphide gas. decaying vegetable matter.
3. By dust	particles of dirt. excrement. sputum, etc.
4. By bacteria	coughing. sneezing. expectoration.

The air space needed by an individual will depend upon several factors as, nature of work, location, whether in a factory or dwelling. It is a fairly fixed principle that a 1000 cubic feet of air space be allowed each person and at least 3000 cubic feet of air every hour.

The air is purified by the following natural agents:

1. Sun.
2. Plants.
3. Winds.
4. Rain.

The sunlight is the master sanitarian in the tropics, it kills most of the germs in the air and wherever it penetrates it disinfects.

The plants absorb carbonic acid gas from the air and return oxygen.

The winds distribute the air and thus make uniformity in composition.

The rain is a purifier by carrying down suspended particles of dust, etc.

WATER AND WATER SUPPLIES.

The purity of water is an essential that cannot be ignored in the tropics if one is to escape the many diseases in which water may be the vehicle of transmission. The customs of the natives are such that they can never be depended upon to safeguard the water supply either at the source or in the home, and the safest course for the foreigner to follow is to exercise constant supervision over the water that he and his family use.

The supply of water either directly or indirectly comes from the rainfall—it may be from wells, springs, ponds, surface water or collected from roofs and stored in tanks. The water in the stream may be as clear as crystal and be heavily contaminated by disease germs and parasites, due to the custom of the natives of defecating on the ground, whence the feces are scattered by animals and carried by the rain into streams.

In some countries the natives defecate on the banks of streams and into the stream itself. Tropical climate and native customs are ideal for keeping alive in a community many diseases which with higher sanitary standards would be eliminated (in temperate regions the conditions are not so favorable for germ life).

It should be a fixed principle with the foreigner in the tropics never to drink raw water, no matter how clear it may be, and no matter how free from possible pollution the surroundings appear to be.

Water not only carries the germs of typhoid fever, dysentery and cholera but sometimes is the vehicle of transmission for the exciting cause of ulcers, ringworm, itch, etc.

The easiest method of treating water is by boiling; and to be thoroughly sterilized the water should be allowed to boil for twenty minutes then allowed to cool, properly covered, after which it can be placed in bottles and sealed. Filtration is a reasonably safe method when germ-proof filters are used; the ordinary filters on the market can only

remove gross material and does not prevent germ life from passing them. The modern community plants use liquid chlorin to kill germ life in water.

FOOD.

The function of food is to replace body tissue and supply energy. New tissue is formed and old tissue repaired, and is accomplished by that part of the diet that is assimilated. This important function can only be secured by a balanced ration.

Food is divided into five classes:

1. Proteins.
2. Fats.
3. Carbohydrates.
4. Salts.
5. Water.

1. **Proteins or Proteids.**—Proteins or proteids are tissue builders and repairers and form the chemical basis of all living animal and vegetable cells. They regulate oxidation, are heat producers and form fat. The body demands a daily fixed amount of proteins which are not dependent upon the work done, as is the case with fats and carbohydrates. Proteins are not stored in the body and any excess must be used up and eliminated, chemically all proteins consist of oxygen, nitrogen, hydrogen, sulphur and frequently phosphorus.

2. **Fats.**—The function of fats in the body is the formation of fat and the production of heat and energy. The end-products of the fats are carbon dioxide and water. Any excess of fat is stored up for the future needs of the body. Fats are nitrogen-free, being chiefly made up of hydrogen, carbon and a small proportion of oxygen.

3. **Carbohydrates.**—Carbohydrates act in a similar way to fats, supplying energy and heat to the body. They are made up of hydrogen, oxygen and carbon. All carbohydrates are absorbed as sugar.

4. **Salts.**—If there is a deficiency of salts in our dietary a state of malnutrition soon results. The salts of vegetable acids found in fruits and vegetables are a necessary part of a ration. Common table salt is the chief mineral element and is absolutely necessary to the blood and tissues. Without sufficient common salt there can be no digestive actions by the salivary juice nor chlorin for the hydrochloric acid of the gastric juice, nor could the carbohydrates or nitrogenous compounds be properly digested. The fact should not be overlooked that many persons eat too much salt, and this is especially an evil if there is any tendency to gout or puffiness of the ankles in the later afternoon.

5. **Water.**—The average person consumes two and a half pints to four pints of water daily. Water is an absolute necessity of life; it does not undergo any change itself in the body, but its presence is a necessity for the chemical changes that take place in other foodstuffs.

The white man in the tropics must avoid the tendency to over-indulgence. There is already a heavy enough strain on the body organs without adding by consuming too much animal food.

The usual custom of the foreigner is to take a light breakfast, consisting of fruit, toast and coffee, just before leaving home. Lunch is served between 12 and 1 o'clock, and is usually a substantial meal, consisting of fish or meat, vegetables, fruit and refreshments. The dinner meal served in the evening is similar to lunch. The longer a person remains in the tropics, working under average conditions, the more simple the meals become. It is a mistake to eat more than three meals a day and a wise plan to eat only when hungry.

CLOTHING.

The clothing used in the tropics must be permeable to air and allow of the free exchange of gases; it should be porous enough to permit air to the body and the free passage of carbon dioxide gas which is constantly being excreted by the skin. Woolen flannel is the most permeable of textile material, and linen the least; wool absorbs more than silk, cotton or linen.

The best absorbing power of garments depends upon the color and not upon the texture; white absorbs least, then khaki, olive-drab, green, red, brown, blue and black; thus white is the best for outdoor wear in hot weather.

Underclothing.—Thin woolen material is probably best for underwear in the tropics; the objection to wool is the irritation and care necessary in washing to prevent shrinking.

Silk possesses all the qualities of wool, but in very warm weather it becomes sodden with sweat and is then a too good a conductor of heat to be of real service in the tropics. Cotton fabrics are more generally used in the tropics for underwear, shirts, pajamas, etc. The use of the abdominal belt of woolen or flannel will be found to be of very great service, especially by those having a tendency to intestinal disorders. It should always be remembered that clothing when damp or wet becomes a good conductor of heat, and the risk of remaining in damp clothes should never be lost sight of.

Outerclothing.—The outer clothing should be as light in weight as is possible and of white or khaki in color, white reflects the heat and absorbs very little but the chemical rays of the sun pass readily through it. The so-called solar fabrics have a white outer surface and a black-red or orange on the under surface. Red and orange absorb the chemical rays.

Head Covering.—The white or khaki colored taupee is ideal for the tropics. It should be well ventilated and this is done from below with an internal band so arranged that the head does not touch the frame of the hat. The helmet should have a broad brim lined with green and it is better to prolong the brim down the back of the neck. The neck extension of the helmet should be lined internally with red, yellow or black.

It has been recommended that when white men are compelled to work under the tropical sun and have their backs exposed to the sun's

rays that they sew into the shirts along the spine a strip of yellow and red or black silk. Blondes stand the tropical climate as well as brunettes, everything considered.

The intense glare may cause eye smarting and strain and should be overcome by glasses.

To sum up, white clothing is the coolest and black the warmest. Clothing should be as light in weight as is possible, and loose fitting in order that the heated air may arise from around the body. Wet and damp clothing takes the heat out of the body and should be changed for dry as soon as is possible.

Clothing at Night.—While sleeping the heart-beats lessen and there is not the heat made as when the person is moving around, and the body unless covered will become chilled, this chilling causes the body resistance to be lowered and opens the way for colds, pneumonia, intestinal disorders, etc.

HOUSES.

There are three factors that should guide in providing a home in the tropics; (1) site, (2) construction, (3) ventilation and (4) drainage.

1. **Site.**—The site selected for a dwelling should be elevated and on sloping ground and as far as possible from the native village. Clay soils are to be avoided as they are usually damp. Sandy or gravel soils are the most desirable and more especially if covered by short grass.

2. **Construction.**—The tropical dwelling should be constructed of non-conductor material such as hollow-tile, concrete block with center air space, treated brick or mud. The frame house is most frequently seen in the tropics, and this fact does not mean that the wooden structure is the most desirable, on the contrary they are more expensive over a term of years and maintenance much greater than buildings of solid construction on account of ravages of insects, such as wood eating ants, and rapid deterioration in the wood from exposure to high temperature and heavy rains. In most sections of the tropics today the permanent buildings, that is to say, structures to be used for a period of over five years, are being constructed of solid material. All dwellings should be planned with foundation pillars or walls of solid material to prevent rotting, moisture absorbing and as a measure against rats finding a resting place under ground floor when that is of concrete. The foundation walls where the first floor is to be of concrete should be settled into the ground to a depth of at least 18 inches.

The two storied house is far more preferable than the bungalow, there is a monotony in cooking, eating, living and sleeping on the same floor level. Ample verandah space on all floor levels should be provided and the verandah should extend all around the building. For sanitary reasons it is advisable that dwellings be elevated above the ground, the height will vary with the contour of the surface, but in any event the distance from the surface of the ground to the lowest sills should be such as to admit of free and easy inspection of the area and for the free passage of light and air. Bungalows may be elevated to a height of

seven feet and the surface of the ground concreted and the space used as a wash and dry room in the rainy season.

3. **Ventilation.**—All dwellings should be so constructed that air currents can pass through the building. Every room should permit of its being flooded by sunlight. Doors and windows should be arranged so that there will be a movement of air naturally and not dependent upon the use of mechanical devices to create a change of air.

4. **Drainage.**—No building in the tropics should have roof gutters unless they are absolutely necessary for the collection of water, for the simple reason that all gutters sooner or later sag and retain debris and invariably become mosquito breeding places. Concrete drains on the surface of the ground in line with roof edges and graded to the street drain will handle satisfactorily all roof water and prevent accumulation in the yards. Damp areas due to seepage can be made dry by installing subsoil pipes. Tropical homes built on correct lines and by this is meant that particular attention has been given to the details of location, light, ventilation and drainage have met the first and most important requirement for the proper colonization of the white men in the tropics.

DISPOSAL OF REFUSE.

No dwelling can be called complete unless provided with some sanitary method for disposal of refuse matter and body evacuations.

Refuse matter may be classified as excreta and refuse. The safe disposal of excreta is the more important and will be considered in detail. Some religious sects enjoin their people to bury all body evacuations and if this were properly carried out by all peoples many soil pollution diseases would be eradicated.

The following methods of disposal of excreta for homes in the tropics have been recommended where a modern sewer system cannot for any reason be installed, *i. e.*:

1. Septic tank.
2. Receptacle, *i. e.*, bucket or pail.
3. Incineration.
4. Pit.
5. Canals.

1. **Septic Tank.**—Septic tank or biological treatment is dependent upon the action of organisms which liquify and render inodorous the feces received into the tank and are very satisfactory when properly constructed and located. The septic tank principal can be adopted to serve large concentrated communities.

2. **Receptacle.**—The bucket, tin or tub system requires a collection service that is difficult to maintain at a satisfactory point of efficiency. The labor ordinarily available for this work is not dependable and constant supervision is absolutely necessary in the collection and disposal of the material. The receptacle system of excreta disposal is a reasonably safe method when properly carried out but is almost always looked upon as a temporary measure.

3. **Incineration.**—The disposal of excreta by burning is a safe method and may be accomplished by the open fire or in specially constructed incinerators.

4. **Pit Privies.**—Pit privies are frequently the only practical method for excreta disposal in the tropics, and are satisfactory when properly located with drainage away from the water supply, and constructed so that flies and mosquitoes will not find a breeding and harboring place in the vault.

The depth of the privy will depend upon the sub-water level and the number using the pit. Where the soil is firm the pit may be sunk to great depths and it will be found advantageous to allow a depth of twenty feet or more; pits at this depth will not, as a rule, become fly breeding places because the sunlight will not reach the contents of the pit. The selection of a breeding place by flies appears to be determined in some way by the amount of sunlight reaching the area.

If a shallow pit has been determined upon the depth should be not less than eight feet, and it is suggested that a layer of stable manure, about four inches in thickness, be spread at the bottom of the pit to hasten nitrification of the fecal contents.

The ventilation of all systems of excreta disposal is an essential, for the pit type the flue must be carried into the vault for a distance of at least three feet and preferably five feet and above the superstructure for three or four feet. Every pit privy should provide a small seat for children.

5. **Canals.**—In coast towns it is sometimes more economical to handle excreta disposal by constructing a series of canals which connect with the sea. If the drains are graded properly, the sides are kept free of grass and debris and the outhouses placed in such a manner that the feces are received fairly in the center of the canal, the results are satisfactory and maintenance charges almost nil.

It should be remembered that any system will require supervision, and the best method of excreta disposal for any community can only be arrived at after a thorough study of conditions affecting the community. It is unwise to make a snap recommendation which cannot in some instances be championed if challenged.

Refuse disposal, such as household refuse, stable and street sweepings and general litter are best disposed of by burning in the open fire or in an incinerator. The sanitarian's problem in the tropics is to train the people to place refuse in cans or boxes for collection. They are so accustomed to depend upon the buzzard, hog, dog or fowls to dispose of same that it is only by a system of fines and punishments that they can be taught to use garbage receptacles.

INSECTS AND DISEASE.

Aside from acts of God manifested as devastating earthquakes, floods, droughts, etc., the struggle of the human race, and more especially the white race, to maintain a foothold in the tropics has ever

been a contest with insect life. The tropical conditions are especially favorable through the year for the propagation and development of some form of insect life, together with a great area so sparsely settled that it is not to be wondered at, in the light of our present knowledge of disease transmission, that the human has been forced at times to abandon fertile areas on account of certain diseases the organisms of which we know is spread by insects.

Some species of insects enter into the daily life of all human beings, they live in most intimate contact with us in cleanliness and filth, and we are dependent upon some for certain necessary articles; witness the insects that produce honey, beeswax, silk, etc.

Insects may transmit disease germs in three ways, *i. e.*:

1. Intermediate host.
2. Mechanical.
3. As a vehicle.

1. The mosquitoes, fleas and ticks are hosts for disease-producing organisms that may or may not undergo changes or further development in the host.

The mosquito is the sole means of transmission of yellow fever, malaria, dengue and filariasis.

The flea transmits the B. pestis.

The tick transmits the spirocheta of relapsing fever.

2. Mechanical transmission is affected by the fly, ant, cockroach and any insect or animal that feasts on or inhabits fecal matter, garbage, contaminated articles as in a sick room, and later has access to man's food and water supply and to his person.

3. As a vehicle it has recently been shown that the digestive fluid of the common house-fly is a favorable medium for the growth of tubercle bacilli and this germ has been found in great numbers in the fly's droppings. The germs of enteric fever and cholera grow and multiply in the intestines of the fly. These organisms do not appear to injure their host which is different from the action of the Bacillus pestis on the flea.

It is reasonable to assume that all blood sucking insects and animals are possible carriers of disease. Germs and a study of their habits and life-cycle should be made in order to intelligently combat them.

The insects known to be active agents in the transmission of disease germs are given below:

1. *Fleas.*—Plague germs are carried to humans by the rat-flea.

2. *Flies.*—The common house fly transmits typhoid fever, tuberculosis, diarrhea, cholera, dysentery, maggots in wounds, skin and eye diseases.

3. *Biting Flies.*—The tsetse fly conveys sleeping sickness.

4. *Mosquitoes.*—Mosquitoes transmit yellow fever, malaria, dengue and filariasis.

5. *Lice.*—Body lice transmit typhus and relapsing fever.

6. *Ticks.*—Ticks convey mountain fever, relapsing fever, and cattle fever.

Bed-bugs, ants and sand-flies have been charged as vehicles of transmission of disease germs but the case has not been definitely proved against them.

Tropical medicine is especially concerned with the following orders and families of insects:

1. The Anoptera—lice.
2. The Hymenoptera—ants.
3. The Hemiptera—bugs.
4. The Diptera—flies, biting and non-biting.
5. The Siphonaptera—fleas.
6. Arachnida—mites, ticks, spiders, scorpions, etc.

The Anoptera.—This order includes three species of lice which infest man:

1. Body louse.
2. Head louse.
3. Crab louse.

The lice are blood-sucking insects and as such must be regarded as probable agents in disease transmission as a vehicle or even host. Recent studies indicate that the bite of the louse is harmless in itself and that the disease germs are conveyed when the insect has been crushed and rubbed into a raw surface caused by scratching.

Destruction of lice may be accomplished with ammoniated mercury, kerosene, and the "nits" in the hair can be easily removed with a comb previously dipped in vinegar. The clothes should be treated with live steam and exposed to direct sunlight. The hair of the axilla, groins, etc., should be shaved.

The Hymenoptera.—This order includes the stinging insects, *i. e.*, ants, bees and various worms. There is no conclusive evidence that any of these insects convey disease germs, but the habits of certain ants, for instance, suggest the possibility of this and warrants their being placed in the suspicious class.

The Hemiptera.—There are several families of bugs which under ordinary conditions are inoffensive, but at the same time are capable of inflicting painful wounds.

The specie concerned in the spread of disease is the bed-bug, and it has been charged as a disseminator of leprosy, kala-azar, yaws, tuberculosis and skin diseases.

The bed-bug must have a feed of blood before each moult and before egg-laying; if the blood is not available the moult is delayed. It is a slow feeder, taking about fifteen minutes to complete a meal, and feeds every twenty-four to thirty-six hours.

In addition to be a probable spreader of disease the bed-bug is a nuisance, and is only found in dwellings where cleanliness is not given first consideration.

The Diptera.—This order includes mosquitoes, sand-flies, midges and house-flies.

Mosquitoes.—The culicinæ transmit dengue and filaria.

The Ades calopus transmit the virus of yellow fever.

The Anophelinæ transmit the organism of malaria.

In each instance it is the female that does the biting. It needs blood and must have it before ovipositing. The male never bites and subsists on vegetable juices. The first three stages of the life cycle are spent in water, *i. e.:*

1. Egg.
2. Larvæ.
3. Pupæ.

Mosquitoes differ markedly in their habits, the calopus is essentially a domestic mosquito and usually spends its entire life near the place it matured. The culex will breed in almost any collection of water, as marshes, pit privies, wells, stagnant pools, etc., and are great travelers. The anophelinæ select quite shaded collections of water in which aquatic plants and animal life abound, and upon these the larvæ feed.

The time of development of the mosquito from egg to adult will vary with the temperature, but the average time is about ten days. It is recommended, however, that in order to destroy early maturities mosquito brigades be organized with the view of covering the area, in which a mosquito eradication campaign is being conducted, in seven days. The anopheles will breed in brackish water when a more favorable place is not available. The anopheles is not ordinarily a long-distance flier, but it has been proved that a flight of over a mile is not unusual, and this fact should be kept in mind when estimating the cost of an antimalarial campaign.

The following measures if consistently carried out will rid a community of mosquitoes:

1. Reduction of number of infected humans	daily dose of quinine.
2. Bite prevention	mosquitoes at night. screened houses. chemicals to exposed parts of body.
3. Antilarvæ measures	drainage, training streams. filling, grass cutting. oiling, collection of containers.
4. Sanitary works	water and sewer system. paved streets. concrete drains.

Of the above measures the following have been placed in the order of their importance for communities where a complete organization can not be developed for the early days of the campaign of mosquito reduction:

1. Drainage.
2. Grass-cutting.
3. Bite prevention.
4. Reduction of infected humans.

Sand-flies.—There are two classes of winged insects known as sand-flies, *i. e.,* Simulium or Buffalo gnat and the Phlebotomus or owl midge.

In each case it is the female that bites and seeks blood, the male being harmless.

The Simulium breed in swift-running streams and the Phlebotomus in damp earth and in the dejecta of lizards.

These little flies are believed to be the agents in the transmission of certain tropical fevers. The Buffalo gnat causes great damage to cattle by attacking the eyes, ears and nose.

The following measures have been suggested to combat these flies:

1. Good walls and floors in dwellings, all cracks and separations to be filled by putty, wax or similar material.
2. Painting the walls and floors; whitewashing is not satisfactory.
3. All interior woodwork to be painted once every year.
4. The use of a fine mesh mosquito bar while sleeping.

Midges.—Midges are blood-sucking insects, and in addition to making life miserable when present in any considerable numbers, must be looked upon as possible agents in the dissemination of disease germs. One species of midges is aquatic and passes the stages of development like the mosquito; another species is entirely terrestrial, breeding in garbage heaps, decayed vegetable matter, collection of rotting wood, etc.

House-flies.—The common house-fly, or Musca domestica, cannot bite, although the popular opinion is quite to the contrary, because its mouth parts are constructed for liquids only. The favorite breeding place for this fly is horse manure, but in the absence of this material the fly will deposit her eggs on any decaying matter, including human excrement.

There appears to be one constant requisite for the selection of a place in which the fly will deposit her eggs, and that is a certain amount of sunlight must reach the site. It is a well-known fact that pit privies of great depths are never troubled by flies even though the privies be located in the house proper, similar results are obtained when the interior of pit privies are coated black. There are two species of the house-fly, the large and small; they are alike in habits, selection of breeding place and disseminators of disease germs.

The Stomoxys calcitrans, or stable-fly, is a true biting fly and closely resembles the house-fly, and in rainy weather will invade the home in great numbers. Under these circumstances persons have been bitten by this fly and confused them with the house-fly, hence the popular belief that all flies bite. The time of development of the fly will vary somewhat, but under favorable conditions the average time from egg to adult can be placed at from eight days the earliest to twelve days the ordinary maximum.

The Fly as a Disseminator of Disease.—The fly must be an important factor in the spread of disease when we consider the ease with which it can pass from filth collections laden with pathogenic germs and the complete access it has to our food and water supply, and, further, the desire of the fly to alight on the membranes and ulcers, there to start the pruning process of its legs and wings.

The role of the fly as a mechanical disseminator of germs would seem to have been overestimated, and this is quite probable, as the fly is an intermittent feeder and is inactive for some time after each feeding, and the probabilities are that most of the germs and parasites that the fly may have attached to its mouth parts and legs while feeding have perished before reaching a favorable medium for growth. It has recently been shown that the digestive juices of the fly constitute a favorable medium for the development of the tubercle bacillus, and the organisms of cholera and enteric fever multiply in its intestines.

Preventive Measures.—The fly has many natural enemies, such as the common house centipede, certain ants, beetles and small mites that cover its body and gradually destroy it. The fly is destroyed in great numbers at the close of the season by a fungus. Other measures of prevention consist of:

1. Screening all doors and windows.
2. Proper disposal of all refuse.
3. The use of sticky papers, poison papers, and traps.
4. Cleanliness in the home.

The Siphonaptera.—The flea consumes an enormous quantity of blood in proportions to its size. The rat flea lives primarily on the rat and only leaves it when the rodent becomes cold, and then the flea seeks the first warm-blooded host, it may be another rat or a human being. Martin has recently shown that the rat flea is itself diseased when it transmits the plague bacilli to man. The sick flea sucks blood constantly and regurgitates it, mixed with bacilli in the flea's gullet. The flea is found more abundantly in dirty dwellings, old buildings and in places which are frequented by persons of unclean habits. Species of flea live on dogs, cats, pigeons, poultry, squirrels, etc.

Arachnida.—Arachnida are not true insects, they possess many different characteristics, the more prominent of which is their having eight legs, whereas the true insects have only six. The members of this group which affects humans in the sense of disease transmissions are:

1. Mites.
2. Ticks.

1. *Mites.*—The itch mite causes skin eruptions, which are troublesome; the mite burrows into the skin at the axilla, back of the hands, fingers and toes. This mite has been charged with conveying leprosy.

The harvest mite, or red-bug, is very abundant in warm countries and causes intense itching, redness and swelling of the affected parts, and if scratched may suppurate.

2. *Ticks.*—These make up the larger part of the animal kingdom and carry disease germs to animals and to human beings. In habits they resemble the bed-bug; they infest huts and camps, and during the day live in cracks in the floor and walls, coming out at night to bite. The ticks are slow feeders and can only get sufficient blood from a person asleep.

The species *O. maubata* is the disseminator of the spirocheta of the African relapsing fever; this organism is not only spread by the tick

but passes in eggs of the ticks to the larvæ, and in this manner the adult tick is already infective. The fact that an organism can be passed to the eggs of an insect explains the spread of disease to great distances, which in many instances has been a difficult problem to solve.

SOIL POLLUTION DISEASES.

Filth that is not disposed of in a sanitary manner or carried to the sea is deposited on the ground, and in the tropics, where the custom of the natives, necessary degree of heat and moisture are present throughout the year it is not difficult to understand that pathogenic organisms and parasites find ideal conditions for multiplication. Were it not for Nature's scavengers, the sun, bacteria in the soil and certain animals, such as the hogs, buzzards, chickens and dogs, soil pollution diseases would have long ago annihilated the human race in the tropics, surely in those sections having a constant high temperature where these diseases are always present in more or less epidemic proportions. Experiments point to the fact that most animals that subsist in part on human excreta are immune to the effects of the pathogenic organisms, and most parasites contained therein, and, further, these organisms are apparently destroyed in the body of the host.

The organisms causing any of the soil pollution diseases leave the body of the infected person in the feces or urine or both and enter the body via the mouth and in the case of the hookworm through the skin. The elimination of soil pollution diseases in the tropics resolves itself into the problem of the sanitary disposal of human excreta. The solution of this problem is comparatively easy in that we know the measures that can be applied and get results, but the difficulty comes in the application of the measures due principally to lack of funds and indifference of the people. On the whole the soil pollution problem is less difficult to accomplish than the elimination of mosquitoes, as the area to be treated with the former is more circumscribed and the interest of the natives more easily awakened, as they can more easily associate excreta as a factor in the spread of disease than they can the mosquito.

The principal soil pollution diseases in the tropics are:

1. Hookworm.
2. Dysentery.
3. Enteric or typhoid fever.
4. Cholera.

1. **Hookworm.**—This disease was first reported from Brazil in 1864, it is world wide distributed and endemic in the warm countries.

Etiology	Order Nematodes. Family Strongylidæ.
Genus	Ankylostoma duodenale. Necator americanus. Ankylostoma ceyclanicum.

Morphology.—In the Ankylostoma duodenale the body is cylindrical and during life is pinkish in color. The mouth carries ventrally two pairs of hooked teeth and one pair dorsally. The male measures 10 mm. in length and from 0.4 to 0.5 in width; the female measures about 12 mm. in length and has the vulva located at the junction of the middle and last third. During copulation they resemble the Greek letter Y. The ova are ellipitical in shape, have thin shells and yolk segmented, size about 60 μ long and 40 μ broad.

Necator americanus is the hookworm prevalent in tropical America in the Philippines. Recent studies indicate that this parasite is very widely distributed over the world. The mouth is small, no ventral teeth, but prominent chitinous plates and a dorsal pair of plates. The life-cycle of the Necator is the same as the Ankylostoma duodenale.

Ankylostoma Ceyclanicum.—Ankylostoma ceyclanicum is the ankylostome of the cat and dog of India. It is smaller than the Ankylostoma duodenale.

Habitat.—The worms live in the duodenum and are frequently found in the jejunum, and fasten themselves with their teeth to the lining membranes and feed upon the villi. The females lay eggs in prodigious numbers, which leave the body in the feces, in which they will hatch out into larvæ in from three to seven days, depending upon the temperature and moisture, and will moult two or more times in the following ten days. The larvæ will remain in water for months and can swim and crawl on a moist surface. The eggs are not infective when ingested by human beings.

Infection by the hookworm may occur via the (1) mouth or through the (2) skin:

1. When the larvæ are ingested they soon pass out of the stomach and moulting takes place up to the fifteenth day. Ova do not appear in the feces, as a rule, until from eight to ten weeks after infection, although the worms have matured and copulated in four or five weeks after the larvæ have been ingested.

2. Through the Skin: The larvæ pierce the skin through the hair follicles and between the toes where the skin is tender and frequently cause a dermatitis, which usually disappears in a few days.

Symptoms.—Some persons may harbor many worms without showing any symptoms while others will suffer grave anemia from a small number and death may occur from cardiac failure, exhaustion or intercurrent disease.

Prevention depends upon the sanitary disposal of the excreta and killing the parasites in the human being. The first measure calls for a sanitary closet and the use of the same by all persons, the second measure is handled by the examination of feces to locate "carriers" or mildly infected persons and treating those found with proper remedies.

Dysentery.—This is a serious disease in the tropics and exacts an enormous toll each year. There are three chief types of this disease met with, namely:

1. Dysentery caused by amebæ.
2. Dysentery caused by bacteria.
3. Dysentery caused by irritants.

1. **Amebic Dysentery.**—Amebic dysentery, may be caused by any one of the three species of amebæ that are distinguishable under the microscope, *i. e.*, Entameba coli, E. histolytica and E. tetragena; this later species is believed by Walker and Craig to be a cystic stage in the development of the E. histolytica. The E. coli is considered by some investigators to be a harmless parasite as far as true dysentery is concerned.

Habitat.—Amebæ are found in surface waters all over the world, but are especially abundant in warm countries. The organism found in the human has been classed as entameba and is a true parasite, but does not multiply outside of the body of the host. This organism is found in tropical surface waters in various forms.

2. **Bacillary Dysentery.**—This type of dysentery has been divided by Hiss into four classes, the causative agent in each instance being closely allied bacilli, *i. e.*, the Shiga, Hiss-Russell, Flexner-Strong and the Harris. The organisms can be differentiated by agglutination and fermentation tests.

The Shiga bacillus is found in the stools of cases of B. dysentery more frequently than the other types of organisms. B. dysentery is usually the epidemic dysentery of armies and at times the disease becomes highly infectious.

3. **Dysentery Caused by Irritants.**—This is the so-called catarrhal dysentery and may be caused by bad food, purgatives, intemperance, etc.

Prevention.—Dysentery follows the ingestion of contaminated foodstuffs, or drinks of feces which contain the causative organism. It may be water-borne or carried by flies and other insects, and by direct and indirect contact with a person ill with the disease or a person recently recovered who stills harbors the organisms.

The preventive measures consist in isolating the sick, boiling all water used, sanitary disposal of the feces, protection of foodstuffs and drink agents, flies and other insects that might have had access to excreta. All vegetables and fruits are safe when cooked.

Enteric or Typhoid Fever.—Enteric or typhoid fever is one of the most formidable diseases in the tropics and is responsible for much sickness and many deaths. Typhoid attacks native and foreigner alike.

Typhoid fever is caused by the B. typhosus and is characterized by continuous fever, lasting on an average of about three weeks, and a persistent diarrhea with the stools resembling rice water.

The typhoid germ leaves the body of an infected in the excreta and urine and the new victim must take into the body via the mouth some of the feces or urine of an infected person. The contaminated article may be foodstuff or drinks, by the fingers, or from handling soiled linen or utensils used by the sick.

Typhoid fever is world-wide distributed and readily assumes epi-

demic proportions whenever conditions are favorable. Milk and oysters are common vehicles of transmission of bacteria in general and frequently of the Bacillus typhosus.

Prophylaxis.—The problem in preventing the spread of typhoid is to render the carrier safe, and "carriers" are especially dangerous if they handle foodstuffs. Inoculation to prevent typhoid is a measure of prime importance and should always be carried out whenever practicable. Further preventive measures consist in isolating the "carrier," disinfecting all stools and urine, boiling all water, prohibiting eating uncooked vegetables, all fruit to be washed and skin removed, eating only the pulp, protection of foodstuffs and drinks from flies and insects that might have had access to infected material.

Cholera.—Cholera has at one time or another visited nearly every part of the inhabited earth. This disease is caused by the Spirillum cholera (Koch), or, as it is sometimes called, Comma bacillus. The disease is carried from person to person by direct contact, contaminated foodstuffs or drinks, fingers, utensils or insects, such as the fly and ant having access to infective material. Cholera has a case mortality of from 40 to 90 per cent., and rarely below 50 per cent.

Symptoms.—Symptoms in the typical case in the incubation period are usually from one to twenty-four hours, accompanied by projectile vomiting and diarrhea, the stools in a short time becoming colorless, urine suppressed and the skin over the entire body shrivelled and death terminates the suffering or reaction sets in.

The Ambulatory Type.—In the ambulatory type the symptoms are mild and the case passes unnoticed. These cases are a menace to others, as they are "carriers" and spread the disease.

Fulminating cases are sometimes seen as a toxemia, causing death before the usual symptoms are manifest.

Prophylaxis.—All discharges, including urine, from the sick should be disinfected and if practicable incinerated. Foodstuffs and drinks should be protected from flies and insects in general. Clothing and utensils of the sick should be sterilized and such articles that cannot be easily sterilized be destroyed by burning. Vegetables to be cooked and fruit to be thoroughly washed and only the pulp eaten.

RODENTS.

In the tropics the most dreaded of transmissible disease is bubonic plague. Rats through infected fleas (Pulex cheopis and Pulex ceratophyllus) are the principal agents in the spread of this disease over the world. In addition to the rats the squirrel and the Siberian marmot are known to be susceptible to plague.

In tropical America rats and mice abound, more especially through the lowlands. These animals belong to the large zoölogical family Muridæ of the order Rodentia, which is estimated to comprise nearly one-third of all species of mammals. The Muridæ includes rats and mice of the genus Mus.

The principal species of Mus found in the tropics are: Mus musculus, Mus rattus and Mus norvegicus.

Mus Musculus.—This species, the common house mouse, is found in large numbers in the inhabited coast regions of the tropics. It does not thrive well in the low temperatures of the highlands. The house mouse is very prolific, being sexually matured at three months. The number born will vary from two to eight per litter, and this sometimes occurs as often as ten times in a year. The house mouse is slender, the average weight not exceeding 17 grams, ears long and covered with fine hairs. The tail always long, sometimes exceeds the length of the body of the mouse, including the head. The color ranges from gray for the indoor specimen to brown for the outdoor specimen. The house mouse is sexually matured at three months.

Mus Rattus.—Ship rat. Black rat. House rat. This is the common house rat, which has a slender body, a long tail, large eyes and ears, the latter being translucent. There are many subspecies of the M. rattus, and the principal variety found in the tropics is the M. Alexandrinus.

Mus Alexandrinus.—Roof rat. Tree rat. The point of origin of this rat is not known, but is believed to be in Egypt. It is firmly established in the tropics, and in some sections is the dominant species. The roof rat is brownish-gray, average body measurement between 15 and 20 cm., and covered with a harsh fur. Its weight does not usually exceed ten ounces. The tail is long and blunted.

Mus Norvegicus.—Norway Rat. Brown Rat ("decumanus"). This is the most destructive rat known, the average weight being about fifteen ounces, but specimens are frequently trapped that exceed forty-five ounces. The ears are small and thickly covered with fine hair. The tail is long, but rarely does it exceed the combined length of the body and head.

Breeding.—The constant, even temperature and abundant food supply which obtains in the tropics offer ideal conditions for rat-reproduction, and the rat population has increased so rapidly in recent years that the rat menace is receiving serious consideration in most tropical countries.

The brown rat is very prolific, more so than the black or the roof rat. The female brown rat usually possesses 12 mammæ, while the black and the roof rat have only ten, and sometimes less. Rats may breed and in fact some do, in every month of the year. The usual breeding season is between January and June, but there is no reason why full-grown, healthy males should not mate at any time. The female sexual season is long and sometimes extends over eight months of the year. The period of gestation is on an average twenty-one days. The black rat and the Norway rat have borne litters when only eight weeks old.

Migrations.—Rats travel long distance, either singly or in numbers, by themselves or are transportated in ships, trains, caravans, etc. When rats migrate in large numbers it is usually due to overproduction or shortage in food supply. In tropical America migrations on a small scale are sometimes witnessed just before or during an epidemic of bubonic plague.

Food.—Rats differ markedly in their food habits. The Norway rat will eat anything and is a good scavenger. The black rat is not a good forager, its food must be clean, and it prefers grain. Rats feed at any time, and they handle their food similar to the squirrel. Any food eaten by man or animal serves as rat food.

General Habits.—Rats in general have defective vision, seeing much better at night, and for this reason are mainly nocturnal in their foraging expeditions. Rats try to follow a beaten path in their wanderings, and when they lose the path, especially in a bright light, they rush forward until they encounter some object, and then depend upon their vibrissæ to guide them to safety. Rats must gnaw some hard material at frequent intervals, in order to keep their incisors at proper length.

The house mouse climbs and swims and jumps; it is not a voluntary swimmer, but performs the task very credibly when tested. It builds its nests in soft material in boxes, book-cases, under floors and between walls.

The black rat rarely burrows but climbs trees, ship cables, electric wires. It is a strong jumper and swims well. The black rat consumes less water than other species. It builds nests principally between walls, ceilings and roof spaces, but rarely invades cellars or drains.

The Norway or brown rat takes to water voluntarily and swims long distances. It climbs, but on account of its great weight and large size the task is clumsily performed. The brown rat is a very adaptable animal, developing in both extremes of temperature. An abundance of water is absolutely indispensable to the brown rat, and its nests are to be found in sewer drains, river banks, swamps and in houses near the water tank.

All rats when hungry show cannibalistic tendencies, but under normal conditions most rats live in peace with their neighbor. The brown rat is the most ferocious and attempts, and sometimes succeeds, in killing or driving off other species.

Rat Control.—This problem is usually approached through (1) rat prevention, and (2) rat extermination.

Rat prevention calls for rat-proofing of buildings, which can be accomplished by single walls, no attic space, concrete foundation walls extending into the earth for at least two feet. The first floor of a good concrete mixture and this overlaid with Mosaic tile. When it is elevated above the surface of the ground area should be cemented.

Food Supplies.—These should be well protected from rats by rat-proofing the larder, also animal feed bins. Garbage collection service should be so arranged that refuse matter can be placed in proper receptacles and the material collected daily and disposed of preferably by cremation. Drains should be thoroughly cleaned out and the opens covered with heavy wire.

Fumigation of ships and protection of the ships' cables by circular disks of not less than four feet in diameter. Wharves of wooden construction, as well as landing platforms, grain storage house, should be replaced with concrete structures.

Rat Extermination.—Rat extermination can be attempted by trapping, poisons, virus, natural enemies.

Trapping.—Trapping is an effective measure when properly carried out. The snap or cage trap give good results when nicely adjusted at rat runs. Traps should be thoroughly cleaned after each catch, and care must be exercised in preventing the human or rat odor from remaining on the trap, and this can best be accomplished if gloves are worn by the person handling the traps.

Poisons.—Bait poisoned with arsenic, strychnine, barium sulphate, phosphorus paste or carbon bisulphide may be used, with good results.

Virus.—Virus to be effective must retain its virulence when placed in rat runs. Meat preparations now on the market lose their virulence shortly after exposure and are rendered harmless so far as causing any disease in the rat; on the contrary a rat consuming virus in less than a fatal dose acquires immunity. At this writing there is no proved virus available that will destroy rats by causing an epizoötic among them under normal working field conditions.

Natural Enemies.—Rats have many natural enemies, such as the owl, weasel, cat, dog and ferrets.

The dog or cat with training can be very useful in any campaign to control rats. The Irish, Scotch and Fox terrior have proved themselves good ratters, their only drawback being that they cannot go into the runs as can a ferret.

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CHAPTER XXIV.

INDUSTRIAL HYGIENE.

By LOUIS I. HARRIS, M.D.

THE IMPORTANCE OF INDUSTRIAL HYGIENE.

From the time when machinery was first invented, and workers emerged from their homes, where they had conducted their industrial pursuits as individual enterprises, to become a part of a complex industrial system, the physical welfare of the workers has as a rule been subordinated, if not completely ignored by factory managers. While hordes of immigrants kept pouring in through our gates, eager to take the places of those millions of workers, who, during the past several decades chose more attractive work or were used up, disabled, and thrown into the scrap heap like so many useless and worn-out machines, the vital necessity of conserving the health and lives of our laboring population was overlooked.

While ordinarily war is a process which is destructive of human life, the world conflict that has just been concluded has paradoxically enough brought about a more widespread recognition of the need of conserving human life than any other event of the century. Immigration stopped, and the soldiers at the front were absolutely dependent upon the men, women and children in industry for the necessities of life and for the instruments of warfare. Thus it became of paramount importance to guard well the lives and health of the industrial army which could not be readily replaced.

As industrial establishments have grown in size and complexity, and the sources of industrial loss and waste have come to engage the special attention of experts, it has gradually become recognized, not as a matter of sentiment or of business ethics, but from the strict standpoint of profit and loss, that the human element in industry is the most valuable one. This view is slowly winning general acceptance, and factory managers are beginning to give attention to industrial hygiene or are engaging physicians or others whose special function it is to prevent disease in industry, so far as possible.

Dr. Frederick L. Hoffman[1] estimated the total number of wage-earners of both sexes in the United States in 1915 as 44,130,000. This estimate is probably more nearly in accord with conditions as they exist today than are the figures of the Federal Census of 1910, which place the industrial population at 33,500,000, and the number of

[1] Kober and Hanson's Diseases of Occupation and Vocational Hygiene, 1916, p. 777.

workers who annually suffer from sickness at 13,000,000. Accepting Dr. Hoffman's higher estimate, there must be a proportionate increase in the number of cases of sickness among workingmen annually. The financial loss through illness, which in 1910 was placed at nearly three quarters of a billion, must, according to Hoffman's estimate, also be proportionately greater. According to different investigators, an average of from six to nine days are lost by each wage-earner per year.

Preventable accidents and disease are largely responsible for this great economic loss. If our Federal Government were arbitrarily to order the shutting down of industry throughout the country for a period of from six to nine days each year, there would be a justified clamor and outcry against the loss it would entail; and yet, manufacturers, generally speaking, are themselves virtually closing down their plants for from six to nine days each year because of their failure to check preventable sickness and accidents; their failure to adopt the necessary preventive measures causes a great financial loss. Not only do the workers suffer a monetary loss from this cause, but, in addition, their future usefulness to society and to their families is frequently greatly impaired and their lives shortened. The losses suffered by the combatants in the great world war were truly appalling, but the destructive process had a definite limit and ceased with the declaration of peace. An almost equally great destruction of the health and lives of the industrial army goes on constantly and with little appreciable diminution, even in times of peace.

Omitting illness and disease, the number of accidents reported for the first seven months of 1917 by the Pennsylvania Department of Labor and Industry alone, offers striking testimony in support of the foregoing statements. From January 1 to August 1, 1917, the total number of workers in Pennsylvania who were killed in the course of their work, was 1877; 139,598 were injured. This necessitated a total disbursement of $4,318,992 by way of compensation for accidents and deaths. These figures give but a slight suggestion of the casualties incident to industrial activity in the country as a whole. Authoritative figures from many other sources might be added to show the enormous toll which industry takes in health and life from men, women, and children in industry, but those here offered will suffice to indicate the magnitude of the problem.

Industrial hygiene is one of the most recently developed branches of preventive medicine and has grown out of an awakening to the significance of conserving the lives and health of those of working age. It derives a special importance from considerations of a humane, social and economic character.

A logical public health program demands that the attention focussed in recent years on the prevention of infant morbidity and mortality, shall comprehend in equal measure the protection of the adolescent and adult members of the community, and especially of those in industry. Industrial hygiene is the particular branch of public health medicine which does in fact concern itself equally with the protection of the adolescent and adult person in industry, and is thus a logical

extension of the boundaries of child hygiene. Communities lavish vast sums of money upon child hygiene activities up to the time that children end their school careers, but make little or no effort to protect them in shops and factories, or to provide periodic medical examinations for the benefit of the individual child and for the good of the State, once they have received their working papers. Public health activity that does not extend the scope of its supervision beyond the school age of the child shows a state of arrested development.

Industrial Hygiene and Occupational Diseases.—Industrial hygiene has to do with the application of the principles of hygiene and sanitary engineering to the construction, equipment, and management of factories and workshops, so as to prevent disease and injury and to promote and to conserve the physical and mental welfare of workers. It is essentially a branch of preventive medicine. When the principles of industrial hygiene are inadequately observed or neglected in the work-place, diseases that are peculiarly characteristic of certain occupations may develop; these may be termed specific occupational diseases. On the other hand, the health of the worker, or the condition of one or more of the vital organs of the body, may be undermined by improper industrial conditions in such manner as to produce, or predispose to general or local diseases of a type which, while not peculiar to any one occupation of those engaged in industry, may be termed non-specific occupational diseases.

Too often, the term industrial hygiene is used as if it were synonymous with occupational diseases. It is well to emphasize, therefore, that industrial hygiene applies only to measures for the prevention of specific and non-specific occupational diseases. Diseases of occupation comprise a distinct branch of clinical medicine arising out of the neglect of industrial hygiene.

A factor that has persuaded factory managers of the need of protecting the health of employees, is the desire to check the ceaseless changes in the personnel of the working staff of large industrial organizations. This change, resulting from dismissals, retirements or change of place of employment, in the hazardous industries particularly, is at times so great that in order to keep up a working force of 1000 men it has frequently been necessary to engage from 6000 to 10,000 or more employees per year. This ceaseless ebb and flow in the tide of workers who enter and leave factories is known as the labor "turnover." The desire to reduce labor "turnover," by making the conditions of work satisfactory, is in a measure at least responsible for the installation of health safeguards in many establishments.

Another factor which is stimulating the interest of factory managers in industrial hygiene is the fast growing demand for sickness insurance (spoken of generally as health insurance). Compensation for non-specific, as well as for specific occupational disease, will stimulate the promotion of efforts to prevent such diseases, in much the same way that compensation for accidental injuries and death led to the rapid development of the "safety first" movement.

SCOPE OF INDUSTRIAL HYGIENE.

To make industrial hygiene effective, and to prevent those diseases which are directly or indirectly caused by occupation, requires the carrying out of a comprehensive program which in its essential points may be briefly summarized as follows:

1. **Laws.**—(*a*) There must be formulated definite legal standards to govern factory construction and operation, which are to serve as minimum sanitary requirements. Such laws must necessarily be based upon the study of conditions peculiar to various occupations, upon the facts ascertained from a clinical study of workers, and upon engineering principles which are the result of research and which will show how to eliminate dangers to health arising from the faulty construction of buildings, machinery, equipment, and from hazardous trade processes. (*b*) Laws should be enacted granting compensation for occupational disease. Such laws are a most effective stimulus to efforts for the protection of workers.

2. **Inspection.**—(*a*) There must be official inspection and supervision of work places to ensure the maintenance of sanitary methods and conditions, and to discover and prosecute violations when education and persuasion are ineffective to bring about the correction of insanitary conditions. The reporting of cases of occupational disease by factory managers, industrial physicians, family practitioners and hospital and dispensary physicians should be mandatory. (*b*) The investigation of complaints pertaining to insanitary work-places or hazardous practices is of value as a means of enforcing the laws. The investigation of cases of occupational disease, or deaths from industrial diseases reported by hospitals or private physicians, often discloses the existence of places which are particularly hazardous.

3. **Periodic Medical Examination.**—(*a*) Periodic medical examination of minors as well as of adults, especially of those who enter upon forms of employment which are known to be hazardous or to predispose to disease, and continued supervision of the shops and factories which they enter, should be put into effect.

(*b*) The physical examination of those who apply to public employment bureaus for work is an effective way of instructing them as to the value of periodic medical examinations.

(*c*) The examination of workers in factories is excellent for purposes of research. Such examinations should be conducted at regular and frequent intervals. They are most important in the development of preventive medicine, and their value should be urged upon workers so that their lives may be lengthened, and, that they may be protected against preventable disease.

(*d*) The clinics maintained by health departments for the diagnosis and treatment of tuberculosis are far too narrow in scope. Tuberculosis, while it may be regarded in frequent instances as an occupational disease, is by no means the only vocational disease. If, therefore, tuberculosis clinics were made general diagnostic stations for those

who cannot afford to pay for periodic medical examination, not only would many otherwise undiscovered cases of tuberculosis be diagnosed in their incipiency, but various preventable diseases would be discovered before they had made headway.

4. **Educational Measures.**—One of the chief efforts of public health officials in connection with any industrial hygienic campaign, must be directed to the education of employers and workers alike. Noon-hour talks to workers in factories, lectures before trade organizations of employers and employees, instruction of pupils in vocational schools, the preparation and distribution of placards and printed matter in various languages, are some of the methods through which educational work must be undertaken.

Finally, if it is impossible to convince managers of industry that vast profits result from the adequate protection of workers, and if repeated attempts at education and persuasion fail, public health officials should engage in a campaign of education of the people generally, so as to create a public sentiment in favor of the enactment of legislation which will achieve the desired results.

5. It would be desirable also to compel every factory and shop to keep a record in a book, especially designed for the purpose, of all cases of illness among employes. This record should state the cause, the nature of the illness, its duration and its consequences. Only by such a system can public health officials, employers, and employees intelligently ascertain against which points to direct their attack. In the program here outlined there are comprised several items, each of which is important enough to constitute a special field sufficient to engross the attention of those devoted to their study. Important as are the supervision of work-places by properly constituted authorities, the enforced reporting of occupational diseases and the formulation of standards of construction and management, so as to remove dangerous dusts and other products incident to trade processes, the periodic examination of workers and the proper education of all groups involved are nevertheless of still greater importance.

Education, in so far as occupational diseases are concerned, has practically been neglected. A few schools, however, are making pioneer efforts in this direction. Emphasis upon the education of apprentices and of those attending trade and technical schools is greatly needed. If those who are about to enter industry or who are training in preparation for the assumption of supervisory functions in industry, were to receive adequate instruction as to the sources of danger to the health of workers and as to methods of prevention, a great forward step would have been taken. However, the best health laws and the best system of sanitary organization in industry, must prove worthless if the workers themselves are not taught to coöperate in the prevention of disease and the avoidance of preventable accidents.

The managers of industry are also greatly in need of education, because, generally speaking, they are responsible for the initiation of protective measures to safeguard the health and lives of workers. The

working people, as a rule, are utterly helpless in inaugurating any substantial improvement in the sanitary conditions of workshops except where trade unions are powerfully organized and intelligently directed.

Statistical Data.—Statistical evidence has been furnished in abundance by a number of American writers, particularly by actuaries, and also by a great number of European writers, to prove conclusively that occupation, *per se*, is responsible for a relatively large number of deaths from tuberculosis among certain trade groups. The mortality from tuberculosis in all countries has repeatedly been shown to be greatest among those groups who were exposed to dust, inadequate ventilation or overcrowding. Bartenders, who certainly do not come in contact with any dangerous dust, as well as clerks and stenographers, seem to be an exception to this rule, as judged by Hoffman's comparative table. In the case of bartenders, however, other influences are found at work to undermine the powers of resistance, namely, long hours of work in what is frequently an ill-ventilated place, and sometimes alcoholic indulgence as well, which produce their serious effects and predispose to tuberculosis. Clerks and stenographers, as shown by Guilfoy and Wynne, in addition to many others, rank extremely high as to mortality from pulmonary tuberculosis. As a rule, however, the largest incidence of tuberculosis is encountered in those trades in which dust is generated in considerable degree in the course of work, and, generally speaking, the sharper, harder, and more insoluble the type of dust which is produced in any industry, the greater is the mortality-rate from pulmonary tuberculosis, unless excellent devices for removing such dust are employed.

The following table taken from a study by Dr. Frederick L. Hoffman illustrates the comparative mortality from pulmonary tuberculosis in certain occupations:

PROPORTIONATE MORTALITY FROM TUBERCULOSIS OF THE LUNGS 1907–1910 OF OCCUPIED MALES IN CERTAIN OCCUPATIONS BY SPECIFIED AGE PERIODS.

All occupied males.	15 years and under, per cent.	15 to 24 years, per cent.	25 to 55 years, per cent.
Farmers	9.9	26.9	32.1
Tailors	13.2	52.0	47.5
Carpenters	15.6	32.0	38.4
Masons	17.5	31.1	39.0
Bakers	19.2	24.1	37.2
Iron and steel workers	19.3	27.9	29.7
Painters	23.3	34.7	39.2
Cigar makers	26.3	54.8	45.0
Machinists	27.0	39.3	40.0
Textile workers	27.3	38.6	45.5
Bartenders	30.7	34.1	35.7
Plumbers	32.6	32.8	41.7
Glass workers	32.9	38.5	48.1
Stone workers	33.5	33.3	47.8
Clerks	35.5	42.4	44.8
Printers	37.7	48.4	48.6

In what follows the subject will be treated in two main divisions: (1) A description of the more important occupational diseases, and (2) a presentation of practical considerations relating to environmental conditions from the standpoint of industrial hygiene, more particularly with respect to such subjects as lighting, ventilation, heating and others of like character, which medical officers should know in connection with their industrial hygienic supervision and inspection of shops, factories, and mercantile establishments, and which, though they may seem obvious have been found of practical importance.

CLASSIFICATION OF THE CAUSES OF OCCUPATIONAL DISEASES.

The following is a standard classification of the causes of occupational diseases:

1. Metallic poisons.
2. Poisonous gases, vapors, fumes.
3. Poisonous chemicals, liquid and solid (acids, alkalies, dyes, petroleum products, etc.).
4. Irritating or poisonous dusts (presented in the order of their harmfulness):
   - (*a*) Metallic dust.
   - (*b*) Mineral dust.
   - (*c*) Mixed dust.
   - (*d*) Animal dust.
   - (*e*) Vegetable dust.
5. Infectious materials.
6. Environmental conditions:
   - (*a*) Vitiated air (odors, etc.).
   - (*b*) Excessive humidity.
   - (*c*) Excessive heat and cold.
   - (*d*) Defective lighting.
   - (*e*) Abnormal atmospheric pressure.
   - (*f*) Fatigue, strains, inactivity and posture.
   - (*g*) Dangerous machinery and miscellaneous accidents.

OCCUPATIONAL DISEASES.

In studying occupational diseases it should be kept in mind at the outset that a worker in a given industry, while particularly exposed to one or two metallic, chemical, or gaseous poisons, is often at the same time exposed to a number of other conditions or types of poisons which may be more largely responsible for the development of abnormal clinical conditions than the more obvious and conspicuous industrial poisons. For instance, a worker in a brass foundry is, above all things else, exposed to the development of spelter chills or brass ague, and while one should be particularly on the watch for these conditions, it should at the same time be borne in mind that a number of other agents of subordinate importance, it is true, may produce pathological conditions. Some of these agents are the following: Lead, which is

employed in some alloys of brass in considerable quantities; arsenic, which frequently contaminates the copper or the zinc which are constituents of brass, or arseniureted hydrogen, which may be evolved from the contact of metals with concentrated mineral acids which have not been freed from contamination with arsenic. Excessive heat may produce serious effects, and, finally, the oil which is used in connection with certain furnaces in brass foundries may produce odors which cause anorexia or digestive disturbances. In addition, the indescribable noise which is produced in certain foundries by a certain type of furnace may possibly have some influence in the production of certain nervous manifestations. In some instances, though not frequently, phosphorus is added to the metals which are used to make brass or brass alloys. Under certain conditions a large amount of carbon monoxide may also be present in brass foundries and cause no small amount of injury. In other words, in order to properly evaluate the possible causes of disease in brass-workers one must know something more of trade processes and trade conditions than the mere susceptibility to brass chills. Industrial hygiene studies should furnish a knowledge of these to the clinician.

The therapy of most of the occupational diseases is to only a small degree medicinal. Sanitary engineering is preëminently the prophylactic agent in preventing occupational diseases. The industrial physician must have a fairly comprehensive knowledge of the principles of sanitary engineering to qualify properly as the health guardian of workers.

Anilin Poisoning.—Uses of Anilin.—Anilin is a colorless oil which enters into the manufacture of a great variety of chemicals, which are used especially as dyes and as coloring substances in hair-dyes, as well as for fabrics, and in a multitude of objects made for commercial purposes. It is also used in the manufacture of photographic materials. It has now gained particular prominence in the manufacture of certain explosives. In whatever combination it is found, whether as phenylene, tolylene, diamine, or any other compound, it exercises the same general effects. Poisoning may result from the inhalation of its fumes, from having it spattered on the clothes and absorbed through the skin or from being swallowed with food.

Symptoms.—It produces either an acute or chronic poisoning. In mild cases it causes a general weakness, unsteadiness and dizziness, a slight amount of general blueness of the skin and mucous membranes, with slow movements and a change in manner and speech very much resembling that of a drunkard. In more severe cases the blueness is particularly accentuated, and the patient shows difficulty in breathing, vomiting, bloody urine, and all the evidences of shock and collapse may appear, and the patient may die in coma. Methemoglobin is rarely found on spectroscopic examination of the blood. In chronic cases, in which there is a slow poisoning, there are usually present digestive disturbances, loss of appetite, eruptions of papules or pustules on the body (local irritant action), general weakness, headache, dizziness,

insomnia and fairly marked anemia. The symptoms may develop very rapidly in susceptible persons even when there has been a very limited contact with the poison, as in the case of a man who, when seen by the writer, had been engaged for but a few hours in filling bottles with a special writing fluid that contained anilin. He had allowed his hands to come in contact with the writing fluid while handling the hose through which these bottles were filled. At the end of one day he had marked symptoms of weakness, dizziness, vomiting, headache, intense blueness, with a short period of unconsciousness.

Treatment.—The treatment is immediate removal to a cool spot, change of clothing, the administration of oxygen or artificial respiration, venesection, saline infusion and stimulation.

The cleaning of retorts and stills, as in all other chemicals in which fumes are generated, is a potent source of danger. Frequently, carpenters and plumbers and other outside employees who are called in to do a casual job in a chemical factory are the ones most likely to be overcome. Prevention consists in the elimination of fumes, working with closed retorts and containers, preventing all spattering or soiling of clothes and parts of the body, and by wearing wooden-soled shoes, where anilin oil is likely to accumulate on the floor. Frequent blood examinations should be made and those showing a reduction in hemoglobin should be removed from contact with anilin. There are a variety of anilin dyes which in addition to the characteristic symptoms of anilin, or even without the presence of such symptoms, may cause different forms of skin lesions.

Antimony.—Uses.—In connection with antimony, it is well to bear in mind that aside from its use in the manufacture of steelware and other metallic compounds, and in the making of vulcanized rubber, it is present also in varying degree in type metal. Its symptoms in printers, therefore, must not be overlooked, even though lead is by all means the most important of the poisons to which they are subject. It may cause skin irritation, digestive disorders, weakness, vertigo and feeble heart action, as well as albuminuria. In chronic cases it causes mental depression, irritability, headache, dizziness and general weakness.

Arsenic Poisoning.—Uses.—Arsenic, although frequently mentioned as a source of poisoning when used in the coloring of wall-papers, is no longer of interest from that standpoint, because anilin colors have replaced it for this purpose. It does, however, figure in many occupations where its presence is little suspected. It is a poison in the form of dust (arsenious acid, Paris green, or Scheele's green). It is employed as a parasiticide sheep-dip, for which purpose large vats are filled with a solution containing white arsenic, caustic soda or potash and flowers of sulphur. In the roasting of ores that contain arsenic its presence is a source of danger. It is employed in the manufacture of arsenic colors and dyestuffs and in artificial flowers. It is also used in taxidermy, and it must be remembered that it is found in connection with a variety of metals and mineral acids. Arsenic is present in many metals and also in concentrated mineral acids which have not been

de-arsenicated; when, therefore, metals and mineral acids come in contact arsenic may be liberated as arseniureted hydrogen whose fumes are highly poisonous.

Symptoms.—When the salts of arsenic come in contact with the skin of workers, especially with those who are susceptible, it causes an acneiform or eczematous eruption, and later forms ulcerations, especially where marked perspiration is present. It produces a peculiar pigmentation or bronzing of the skin, especially where the skin is moist. It also exercises an injurious effect upon mucous membranes, causing conjunctivitis, edema of the lids, coryza, dryness and soreness of the throat, and particularly hoarseness. When ingested it has a special tendency to produce gastric symptoms, and in severe cases persistent vomiting, griping and purging. It may produce simple neuritis, although this is not frequently seen. Disturbances of sensation are far more frequently encountered, namely, paresthesia and anesthesia. It is likely to cause a perforation of the nasal septum, which does not, however, affect the anterior or lower margins of the cartilage nor the bones to which the cartilage is attached, differing in this respect from syphilis. At times arsenic has contaminated the sugars that are used in the place of malt in the manufacture of beer.

As fumes of arseniureted hydrogen, arsenic is particularly dangerous. It is to be found in connection with processes of soldering, etching and everywhere in industry where metals and mineral acids are brought in contact, for both metals and mineral acids are frequently contaminated with arsenic. It is liberated in the cleaning of stills, in the process of galvanizing and enameling metal ware.

Symptoms of Arsenic Fumes.—It produces nausea, malaise, headache and very soon marked vomiting. It also causes jaundice of a copper color, which is due to its destructive effect upon the red blood cells, and, as the result, hematuria is often encountered. Besides, it also causes suppression of urine and bladder irritation. It is essentially a hemolytic agent. Although excreted by the urine it is also found in the hair after it has been absorbed through the stomach. The examination of the hair offers a particularly reliable method of diagnosis in medicolegal cases.

Treatment.—The treatment of this form of poisoning is essentially through the administration of oxygen for a long period of time and by saline infusions.

Benzine Poisoning.—Uses.—Benzine is an impure product which is used in the removal of grease and fat, in the cleaning of clothing (dry-cleaning), in India-rubber manufacture, and in waterproofing.

Symptoms.—In acute cases, aside from its irritating effect upon the respiratory system and upon the eyes and skin, it causes nausea and vomiting, and when one is exposed to large quantities of the fumes it may cause drowsiness, weakness of the heart, cyanosis and unconsciousness. When its effects are not quite as profound, it causes marked headache and tremors. In chronic cases it causes headache, tinnitus, hallucinations and general symptoms of "drunkenness."

Treatment.—The only form of treatment is removal of the patient to the fresh air and the application of stimulants.

Benzene or Benzol Poisoning.—Uses.—Benzol is the pure form of benzine. It is being used to an increasing extent in a great variety of chemical processes. It is employed in the making of illuminating gas, in dissolving resins and fats, in dye works, in the manufacture of explosives and by painters as a varnish remover.

Symptoms.—Like all coal-tar products it has a depressing effect upon the nervous system. In acute cases it causes symptoms very much like those of benzine poisoning and is an irritant to the respiratory, gastric and renal organs. It produces weakness, vertigo, cerebral and general "drunkenness," and in severer cases, tremors, pallor, lividity and prostration, terminating at times in delirium, followed by unconsciousness and death. In chronic cases it may cause purpuric spots upon the skin or mucous membrane, or slight hemorrhages from mucous membrane of various parts of the body, and fatty degeneration of the heart, liver and kidneys.

Treatment.—Cases of acute poisoning require fresh air and stimulants. In chronic cases the patient must be completely removed from contact with the substance.

Brass Poisoning.—Brass consists essentially of copper and zinc; variable quantities of arsenic, phosphorus and lead occur in brass either as impurities or because of their purposeful addition. These impurities must not be forgotten in studying brass-workers. The important fact to remember in connection with brass poisoning is that it is the zinc which constitutes the source of poisoning when it is volatilized. Zinc is almost exceptional among metals in that its boiling-point is below 1000° C. However, it begins to volatilize at a very much lower temperature than do many other metals, namely, at 500° C. Fundamentally, then, one would be more correct in speaking of brass chills as zinc-poisoning.

Uses.—Zinc is employed in making brass and bronze alloys, German silver and white metal; it is also used in the process of galvanizing and in the manufacture of rubber articles and paints.

Symptoms.—It is generally believed that the fumes of zinc when inhaled, especially by susceptible persons, cause a superficial searing and consequent necrosis of epithelium and that the absorption of this necrotic proteid material gives rise to the malaria-like symptoms of zinc poisoning, namely, chills, fever, sweating and occasional temperature.

The first effect of the inhalation of zinc fumes is dryness and soreness of the nose and throat, a sense of tightness in the chest, a feeling of lassitude, loss of appetite and a slight cough. These symptoms are encountered more frequently in the winter time, and the chill is first felt when the worker leaves his place of business and comes in contact with the cold, outer air. The chill lasts for a variable period of time and is followed by a feeling of great warmth, during which the temperature is frequently elevated and a profuse perspiration appears. The

entire attack is so well recognized by the worker, and so short in duration, that physicians are rarely called to treat the case. The workers who have suffered a chill feel somewhat weak the next morning, but generally are able to go to work. New men are particularly subject to these attacks, and what immunity is acquired is of brief duration, so that at the end of a brief holiday those who have acquired immunity are once again subject to spelter chills. These attacks are most frequent during the winter season, when the windows are closed, and the fumes which result from pouring the metal are not carried off by adequate ventilating devices.

Treatment.—Treatment of this condition, as understood by all experienced brass-workers, is the application of warmth, the use of drinks, especially milk, and saline purges. Preventive treatment is free ventilation, the removal of fumes caused by the pouring of brass through exhaust devices, and the liberal use of hot milk before and after the pouring process.

Carbon Bisulphide Poisoning.—Carbon bisulphide is derived from coal-tar products and is obtained from the treatment of red-hot carbon with sulphur vapors. It has a chloroform-like odor and is highly volatile and colorless.

Uses.—It dissolves all resins except shellac. It does not, however, dissolve vulcanized rubber. From it is derived carbon tetrachloride and sulphur monochloride, both of which are used to dissolve rubber. It is highly inflammable, and because of its great volatility is used to produce a lowering of temperature in various trade processes. It is applied to the extraction of aromatic oils; it is also used as a disinfectant and for removing grease, as well as to remove oil from seeds and other oily residues.

It helps to combine the sulphur with rubber in the process of vulcanization, making the rubber more elastic and durable.

Persons employing it are particularly susceptible in hot weather, and, as in the case of all dangerous fumes, its effects are most marked when ventilation is not of the best. In general it resembles chloroform in its toxic effects.

Symptoms.—It has a special tendency to produce atrophy and fatty degeneration of muscles and connective tissue and is hemolytic. *In acute cases*, it causes severe headache, pains which radiate from the head downward, dizziness, pallor, a feeling of faintness, nausea and vomiting, marked drowsiness, impulsiveness and unsteady gait. It may cause hallucinations, and death may occur following unconsciousness, coma or convulsions. *In chronic cases* the condition of general weakness and depression, which it tends to cause, is preceded by a period of excitement and general exaltation. Its effects cause it to resemble a case of delirium tremens in many respects, for there follow, after the lapse of a short time, faintness, headache, weakness, depression, insomnia, nightmares and hysterical manifestations; the digestive system is also very much disordered. Still later, there usually follow general emaciation, tremors, localized paralysis, constipation

and anemia, and the case may resemble in some respects one of locomotor ataxia. Mental disturbances are extremely marked. The prognosis is bad in these chronic cases, although the patient may remain alive a relatively long time.

Treatment.—The important feature in the prevention of this poison is extraction of fumes from the workroom and also the prevention of the soiling of the hands and other parts of the body with this agent. There are no specific remedial measures for this form of poisoning.

Carbon Dioxide Poisoning.—Carbon dioxide is generated in varying degrees in places which are close and confined, or lacking in ventilation, especially in the presence of large numbers of persons, and by gas flames or lamps. It is also generated in various processes of decomposition, in distillation, and in tanning. Generally speaking, its presence even in fairly large quantities produces little or no effect. It is chiefly of importance as an index of air contamination.

Symptoms.—It may produce headache, dizziness, a feeling of weakness, difficult breathing and may, as in the case of those cited in the classical description of the "Black Hole of Calcutta," cause delirium and finally terminate in unconsciousness and death by suffocation. In the holds of vessels where fermentable material such as grain or molasses are carried it has been known to be generated in such quantities as to be the cause of fatal poisoning.

Treatment.—Fresh air, administration of oxygen and stimulants are required in the treatment of cases of carbon dioxide poisoning.

Carbon Monoxide Poisoning.—While a great deal has been written about the variety of poisons which produce effects that are almost dramatic in their clinical manifestations, not nearly enough has been said to impress upon medical men and upon factory managers and workers the widespread prevalence of varying degrees of carbon monoxide poisoning. There are a multitude of industrial processes in which these fumes are generated and may produce chronic illness. It is desirable to give special emphasis, however, to the multiplied instances of exposure to small quantities of carbon monoxide which produce mild forms of carbon monoxide poisoning. Carbon monoxide is found wherever furnaces, gas irons, gas-heating devices and improperly maintained heating arrangements exist; also in garages, laundries, various drying chambers and stoves, especially where coke is used, and also where the salamander is employed.

Symptoms.—The susceptibility to carbon monoxide varies greatly. Some are so readily susceptible that they may succumb to its fumes as if they were knocked down by a sudden blow, showing no prodromal symptoms. Usually, however, the patient feels a throbbing in the head, ringing in the ears, gastric distress, nausea or vomiting, weakness in the legs, general faintness, severe headache, dimmed vision and at times suffers from hallucinations. The patient feels knocked out and helpless. Convulsions and coma may rapidly follow. Apfelbach calls particular attention to the fact that carbon monoxide cases in coma, contrary to usual teaching, do not always have rosy cheeks and bright red lips, but

that frequently they show cyanosis and pallor. The former condition is usually found in coma resulting from illuminating and coal-gas poisoning rather than from other sources of carbon monoxide. Fever usually supervenes in cases of coma, the respiration is deep and labored, the blood-pressure at first rises, and subsequently, both respiration and pulse become rapid and feeble. It is generally taught that the spectroscope will show the presence of carboxyhemoglobin. The experience of a number of clinicians who have employed the spectroscopic test, does not, however, bear out this teaching. There must be a considerable degree of saturation of the blood to give this spectroscopic finding. The symptoms of acute carbon monoxide poisoning are very frequently not severe and may consist merely in epigastric distress, a feeling of great weakness, especially in the legs, throbbing in the temples and headache. Pneumonia is a very frequent form of termination in cases of gas poisoning. Various forms of mental disturbance have also followed acute attacks of gas poisoning. Local or extensive paralyses may ensue, although this is very infrequent.

Treatment.—In acute gas poisoning, artificial respiration or the use of the pulmotor and oxygen are of the first importance. The patient should be kept warm and stimulated.

Chronic Carbon Monoxide Poisoning.—Cases of chronic carbon monoxide poisoning are the ones which are the least readily diagnosed and which are probably the most numerous in every industrial community.

Symptoms.—In this form of poisoning patients complain very frequently of headache, dizziness, nausea, vomiting, lack of appetite, weakness, impairment of memory, nervousness, and usually show fairly marked anemia. The symptoms in some cases are extremely few and mild, headache being the only one complained of. There are, however, a group of persons who seem to have a natural tolerance for carbon monoxide and who do not show any symptoms, although exposed for prolonged periods to its fumes. Irritability and so-called neurasthenia as well as disturbances of appetite and digestion, are encountered very prominently among those who are not tolerant. Apfelbach calls attention to the blood changes in chronic carbon monoxide poisoning. He found a tendency to polycythemia and a high hemoglobin content which he thinks are of diagnostic importance.

Treatment.—The treatment for these cases of chronic carbon monoxide poisoning is obviously the removal from an environment in which they are subjected to further poisoning, an abundance of fresh air and general tonic treatment.

Compressed-air Illness, Known as Caisson Disease—"Bends"; "Chokes".—This disease is frequent among those who work under compressed-air and who emerge rapidly from such an environment into a normal one. In the construction of the East River tunnels in New York City, Dr. Seward Erdman and Dr. Keys reported 3692 cases among 10,000 men who were employed in this work. In this tabulation they excluded all slight cases, and Erdman believes that hardly

10 per cent. of all the men employed escaped from the "bends." The accepted theory of the production of this condition is that it is due to the sudden escape of bubbles of gas from the supersaturated blood into the surrounding tissues, upon which these bubbles have a destructive or tearing effect. The blood and all the soft tissues of those who enter a compressed-air chamber become supersaturated with nitrogen, which, if the pressure is slowly reduced, flows off from the tissues by means of the circulating blood into the pulmonary alveoli and is expired. When the surrounding air-pressure is suddenly reduced the nitrogen tends to escape in bubbles from the tissue and blood before it can reach the alveoli, thereby working destruction upon the nerves and muscular tissue in varying degree, some of these larger air bubbles producing compression symptoms upon the peripheral nerves of the central nervous system. This is the generally accepted theory. The greater the amount of pressure the more numerous the cases.

Symptoms.—The symptoms seem to begin when an air pressure of +20 pounds is reached. The New York State laws and other laws have been so framed that the amount of time to be spent by each working man in a compression chamber before entering upon his work, and in the decompression chamber after leaving work, are exactly specified for varying degrees of air-pressure. These laws also specify the length of time the worker may continue under the various pressures maintained in tunnels and other compressed-air chambers.

Prevention.—The most important preventive measure is a curtailment of the amount of time spent by the worker under these abnormal atmospheric conditions. When we reach a pressure of +50 pounds, which is near the maximum permitted, and when for short periods the men are required to work under a pressure of +60 pounds, the working period must be reduced to as little as one-half hour if serious results are to be averted.

Workers who suffer from malnutrition or lowered resistance from any cause, as well as those who are alcoholic and who are easily fatigued, are particularly susceptible. Organic diseases of the heart, blood-vessels and lungs are also predisposing causes. After the age of thirty years there is a progressively increasing inability to endure such exposure. Fatigue is a particularly predisposing factor; fat men are bad risks for work under high pressure.

Sensations under Compression.—The sensations are most varied. Those who work under an increased air-pressure may be entirely free from symptoms, and while there is no absolute immunity, they may experience none of the sensations that are usually described, namely, the pressure upon the ear-drums and the pain and discomfort which it occasions, resulting at times even in the rupture of the drum-membrane. Under compressed air the voice is changed in character and whispering is impossible. The symptoms of caisson disease are never experienced until a workman emerges from compressed air, and they are the result, always and only, of too rapid or insufficient decom-

pression. After a variable period, and sometimes quite suddenly, excruciating pains may be felt in various muscles of the legs or in the abdomen, and a workman will fall helpless to the ground. Abdominal pains are the most frequent of all symptoms; other symptoms depend entirely upon the site of the lesion caused by the bubbles escaping from tissues or the point at which they produce compression. The nervous system is particularly affected. There may be eye or ear symptoms or peripheral nerve pains, or disturbances in sensation of a most varied character. A cerebral gas embolus may produce a great variety of symptoms, depending upon the area of the brain which is attacked. Spinal cord lesions produce the effect of a transverse myelitis or they may produce effects of a localized character. As the result of vascular damage a mottling or spotting of the skin may be seen. Sudden collapse and death are usually due to gas embolus. When the pulmonary vessels are attacked a severe form of dyspnea, called "chokes," is caused. Extensive emphysema of soft tissues may follow. There may be nausea and vomiting. Permanent serious injury or death rarely occurs in those cases which have pains limited to the extremities. These cases are spoken of as "bends." In the milder cases the patients are generally well in a few days. Erdman reports a total of only 1 per cent. of fatalities and permanent injuries among the 3692 cases which came under his notice.

Prevention.—A method of uniform decompression, which is the one most in use, consists in a continuous and uniform rate of reduction of pressure. There is a newer method of decompression which is known as "stage" decompression, in which the worker or patient passes from the place of maximum air-pressure to successive air locks which have a progressively lower air-pressure, so as to necessitate walking and exercise on the part of the patient, which aids decompression. This is an ideal method of decompression.

When cases of caisson disease occur, no matter how serious the case, the patient should be returned immediately to a compression chamber, where he is recompressed.

Treatment.—Some of the most severe cases of paralysis when promptly treated by recompression have responded within a few moments. Recompression must not be delayed. Exercise and massage as well as inhalation of oxygen, and the use of stimulants and heat, are generally depended upon to assist in restoring patients.

Lead Poisoning.—Lead poisoning is also spoken of as saturnism or plumbism. From an industrial standpoint it is the most widely prevalent disease with which we have to deal.

Uses of Lead.—The list of industries in which lead is employed is an extremely long one. It is used in many industries in combination with other substances, and its identity may be so masked as to make it almost unrecognizable, unless one is keenly on the alert to discover its presence. A great deal of caution must therefore be exercised by clinicians in ruling out lead as a cause of disease when they observe symptoms which suggest lead poisoning, even if the occupation of the

person at first sight seems unrelated to the use of lead. It has, for instance, been known that laces or cotton thread have been weighted with lead, and it is recorded by some that persons using such weighted thread in sewing have been affected through biting off such threads between their teeth.

In the mining of lead and in the manufacture of both red and white lead there is a quite obvious source of danger which is easily recognized. In the metal industries lead is frequently employed. It is also met with in type-setting, printing, metal refining, jewelry work, painting, in the glazing of china and earthenware, in the manufacture of linoleum, of electric batteries, glass-cutting, in the manufacture of dyes and varnishes and in many other industries.

Lead poisoning in itself is of serious import, not only because of its toxic action, but because it lowers general resistance and predisposes to tuberculosis. In fact printers, and, in the experience of the writer, painters as well, are notoriously subject to tuberculosis. It is not readily absorbed through the skin, though occasionally one meets with cases of lead poisoning which have resulted from the use of cosmetics and hair dyes containing lead. Lead is not infrequently absorbed through the mucous membrane of the respiratory tract, but, as a rule, it is swallowed in the form of metallic dust and absorbed through the mucosa.

It has been debated whether the inhalation of lead fumes in composing rooms where lead is melted in considerable quantity is a possible source of lead poisoning. While it is difficult to demonstrate the presence of lead in the air in such rooms, it has, however, been definitely shown that in the process of melting, fumes of lead are given off at a temperature very considerably below the boiling-point of lead, and it is because numbers of cases of lead poisoning have been traced to this source, that regulations have been enacted by various communities compelling the installation of mechanical devices to exhaust fumes arising from lead melting pots.

When lead is swallowed and enters the stomach it is converted into lead chloride by the hydrochloric acid of the gastric juice, and in this form it is soluble and capable of absorption. Attention is frequently called to the fact that lead is converted into an insoluble compound by combination with proteids, and on this account unwarranted reliance has been placed upon the capacity of ingested proteids, especially milk, to neutralize the poisonous effects of lead by combining with it. Lead carbonate is more readily soluble than lead sulphate, but both are practically equally capable of causing serious lead poisonings.

The susceptibility to lead poisoning varies greatly in different individuals, females being particularly susceptible. On the other hand one encounters numbers of men who can handle lead with impunity for considerable periods of time and apparently escape its ill effects, while others are exposed to it but a very brief period and develop severe manifestations of plumbism.

Symptoms.—Anemia is usually the first and one of the most pronounced manifestations of lead poisoning and may progress to such a degree as to become quite grave. Oliver reports that from 30 to 70 per cent. of the cases of anemia studied by him showed an abnormal condition of the red blood cells. This change in the red blood cells is a granular degeneration which is evidenced under the microscope by numerous dark, punctate granules which give the red blood cell the appearance of being stippled. These cells are known as basophiles. The stain most useful for demonstrating these basophiles is one composed of 2 grams of methylene blue, 12 grams of sodium bicarbonate and 200 grams of distilled water. The specimen which is to be examined is first placed in absolute alcohol, or a mixture of alcohol and ether, for half an hour; then dried and stained for one minute with the solution just described. The specimen is then washed away with the distilled water until the color is almost faded. The writer in studying more than 420 painters in connection with the industrial hygienic work of the Department of Health of the City of New York, found basophilia present in only 14 per cent. of 122 painters who gave definite evidence of lead poisoning. Although Ehrlich, Grawitz and others speak of basophilia as being diagnostic, Teleky, Biondi and others place very little reliance on this diagnostic sign. The experience cited by the writer would tend to confirm the opinion of the latter that this sign is not of important diagnostic value in lead poisoning.

The lead line on the gums is held to be a very important symptom of lead poisoning by most investigators. The experience of the writer is in accord with that of a number of observers who contend that the lead line is not found in the majority of cases which give evidence of lead poisoning. This lead line, which is a fine blue line seen at the margin of the gums close to the teeth, is found especially in persons who have neglected the care of their teeth. However, it is occasionally found in persons who have kept their teeth clean. The lead line must be differentiated from a soft sediment of lead sulphide which at times appears on the surface of the gums of persons employed in lead industries and which can be easily rubbed or washed away.

Colic and constipation are encountered early in lead poisoning and are important symptoms. The abdominal pain is usually of a very severe character and is accompanied, as a rule, by very marked constipation. Occasionally one meets with cases in which lead is found in large quantities in the urine and in which other evidence of lead poisoning is present, but in which constipation or colic, or even both, may be absent. Lead colic has frequently been mistaken by surgeons for appendicitis, and they have not infrequently operated on the basis of a mistaken diagnosis. Recently a case of lead poisoning was reported to the writer. As the result of an investigation three other cases were discovered in fellow employees. One of these three was suffering from excruciating abdominal pain which led to a diagnosis of appendicitis, and resulted in an operation which disclosed a normal appendix, the abdominal pain continuing after the operation without

mitigation. Having in mind the industrial background in this particular instance, the diagnosis of lead poisoning was suggested and proper treatment overcame this severe abdominal colic. One of this group of three, was a girl who developed sudden maniacal manifestations and who had convulsions. Her case was diagnosed as one of hysteria. The investigator informed the hospital attendants of the probable causative agent and suggested lead poisoning. Subsequent developments confirmed the fact that this was a case of lead encephalopathy.

Headache, though not present in all instances, is a very frequent symptom and is usually of severe character.

As already cited, convulsions, delirium, and other marked nervous symptoms may result from plumbism.

The nervous system, both central and peripheral, seems to be particularly susceptible to the effects of lead-poisoning, and various forms of paralyses, of which "wrist-drop" is the most familiar, are found in this disease.

Miscellaneous Symptoms.—*Albuminuria* is often found not only in connection with the attacks of lead colic but as a permanent pathological condition.

Increased blood-pressure and hardening of the arteries is a frequent result of lead poisoning. The studies of the writer would seem to indicate that workers exposed to lead poisoning for a number of years may show a blood-pressure considerably below normal. This depression, it seems, precedes the characteristic rise in blood-pressure which later develops.

So-called rheumatic pains are very frequently complained of and may be of diagnostic value in association with anemia, colic, constipation, headache and other signs.

The Wassermann reaction in persons suffering from lead poisoning was studied by the writer in 124 cases, and in no instance did it seem that lead poisoning, *per se*, produced a positive Wassermann reaction. Whenever this reaction was obtained it could be explained on clinical evidence or a history of syphilis.

The writer has found the following classification of cases of lead poisoning not only of value for purposes of statistical study but from a therapeutic standpoint as well.

1. The active cases in which there are definite clinical manifestations. The diagnosis in these may rest exclusively on distinctive objective and subjective signs, or these signs may be confirmed by the presence of lead in the urine.

2. The second group are known as latent cases, in which lead is found in the urine occasionally in association with a lead line or with basophilia, but the patient is free from the usual subjective and objective evidences of lead poisoning. In these cases a disturbance in metabolism or the administration of potassium iodide may dissolve the insoluble lead albuminate circulated in the blood or deposited in the various tissues and cause acute manifestations of lead poisoning.

The discovery of these latent cases is of great importance from the standpoint of prevention of active manifestations of lead poisoning.

3. There are borderline cases in which some one or two suggestive symptoms would strongly indicate the necessity of keeping patients showing such symptoms under careful supervision.

Although W. Gilman Thompson places little or no reliance upon the discovery of lead in the urine, in the experience of Oliver, as confirmed by the studies of the writer, the discovery of lead in the urine is of the utmost diagnostic value. The following technic for the discovery of lead in urine elaborated by Durand, has given results far superior to the method more commonly in vogue and is of very great diagnostic value: 200 to 300 cm. of urine are treated with 5 cm. of bromine in a porcelain casserole and evaporated on a hot plate to about 50 cm. The residual mass is then transferred to a platinum dish and evaporated nearly to dryness; 10 cm. of concentrated nitric acid are then added and the evaporation continued to dryness, the residue being again moistened with nitric acid and evaporated to dryness. The residue is then ignited to a low red heat to burn off carbonaceous matter. It is cooled, taken up with 4 or 5 cm. water and 2 or 3 gm. ammonium carbonate, evaporated to dryness and the flame played upon the dish until the ammonia is driven off. It is then taken up with 15 to 20 cm. of 10 per cent. acetic acid and boiled and filtered hot into a small test-tube. It is then cooled and 1 or 2 drops of colorless ammonium sulphide and a drop of 25 per cent. hydrochloric acid added and compared with standard samples, prepared by adding known amounts of a solution of lead acetate containing 1 gram of lead per 1000 cm. Even less than $\frac{1}{40}$ mg. gave a distinct reaction.

Prevention.—Women and children should not be allowed to work at any processes in which lead poisoning is likely to develop. The mixing of dry lead pigments should not be permitted to be carried on where any workers have congregated, without efficient mechanical devices for removing the lead dust generated. All poisonous agents containing lead should be labeled in the language best understood by workers, and such warning should be supplemented by verbal instruction, so that workers may be on guard to protect themselves while engaged in any process in which lead poisoning is a hazard. Personal hygiene is of the utmost importance. Workers should be forbidden under all circumstances to eat in rooms where lead dust may be present. Hot water should be supplied and likewise soap and brushes, and their use should be enforced before each meal and before leaving work. In those trades where lead is employed, the face, and especially the mustache or beard, should be carefully washed before eating and before leaving work. Likewise the mouth should be thoroughly rinsed. No worker exposed to lead poisoning should begin work on an empty stomach. Milk taken before beginning work and also during the day has value as a protective agent. Alcohol should be avoided, as it seems to cause a special predisposition to lead poisoning. Smoking and chewing in places where lead dust exists should be forbidden.

Treatment.—The use of acid lemonade prepared with sulphuric acid or magnesium sulphate, which is so common in trades in which lead dust exists, gives a misleading sense of safety to the workers to whom it is furnished, and its benefits are doubtful. Oliver states that calcium sulphide, one grain every day, given in tablet form to workers exposed to lead-poisoning, has acted favorably as a preventative.

For the colic, hot applications should be applied to the abdomen. Constipation, which is usually associated with colic, may be so marked that cathartics and purgatives may not be effective, and in such cases, small doses of croton oil must be resorted to. Lead colic, when very severe, may require the use of opiates. It is said that it can be relieved by the administration of sodium monosulphate given from one-half to one grain, three times daily. Dr. Stevens of Cardiff administers one-quarter-grain doses of calcium permanganate and claims to have beneficial effects.

In administering potassium iodide to those suffering from lead poisoning, it is very important that small doses should be used at the beginning, otherwise too large quantities of lead may be suddenly dissolved and give overwhelming symptoms of poisoning.

For paralysis due to lead, massage and electricity are generally employed, and are sometimes effective. Sir Thomas Oliver and Mr. T. M. Clague have reported favorable results from the double electrical bath in which the fore limbs are placed in one bath containing a positive electrode and the hind limbs in another containing a negative electrode. In animal experiments a few baths are said to have been effective in promptly removing paralysis. Oliver uses the bath not only as a curative measure in cases of lead poisoning, but believes that its employment once or twice a week is a preventive of lead poisoning. He is not borne out in this opinion to any considerable degree by other observers, and the subject is one for further experimentation.

Mercury Poisoning.—Uses.—Mercury is used in the manufacture of felt hats, in the making of scientific instruments and various kinds of lamps, photographic mounting, and in the manufacture of explosives. It is no longer used in the making of mirrors, for which a solution of silver nitrate and Rochelle salt are now employed.

Symptoms.—Susceptibility varies. The poisoning may be acute or chronic. In acute cases, diarrhea, severe abdominal pain, and in some cases vomiting and prostration are the chief symptoms. Suppression of the urine soon follows. The acute cases are usually encountered in corrosive sublimate poisoning and are rarely seen in industrial practice. In subacute and chronic cases, stomatitis, which involves a considerable amount of inflammation of the mouth, accompanied with pain, is one of the most frequent symptoms. These patients suffer from salivation, the gums become loose, swollen and red and bleed readily, and may discharge a certain amount of pus. The mouth has a foul odor. The involvement of the buccal mucous membrane distinguishes this form of stomatitis from the marked inflammatory condition of the gums seen in workers who are careless of oral hygiene. Loss of appe-

tite is very frequently complained of by those exposed to mercury. Slight diarrhea is also at times encountered. Nervous irritability, while frequently spoken of, was apparently not common in the experience of the writer who examined several hundred of those exposed to mercury. Tremors, both coarse and fine, involving the muscles of the face and the hands principally, and more frequently generalized, are the most prominent of the nervous symptoms and may become extremely severe. Sharp, sudden contractions of muscles have been reported. The tremor when it advances results in an inability to hold objects, and may even make locomotion very difficult. Among Belgians who have at times carried on felt-hat manufacture in the homes, exposing all members of the family to contact with the solution and fumes of nitrate of mercury, some extreme cases have been reported. Such severe cases are apparently not frequent among workers in this city; the great labor turnover may be in part responsible for the lighter forms of mercury-poisoning seen in this city.

The frequency of nephritis from industrial mercury poisoning is apparently an unsettled question.

Anemia and digestive disturbances are very common accompaniments of mercury poisoning.

Occasionally deep ulcers in the mucous membrane of the mouth or upon various parts of the body are found in cases which are suffering from this disease.

Mercury poisoning lowers the resistance and predisposes to tuberculosis and other diseases.

Prevention and Treatment.—Prevention of mercury poisoning can be effected by the use of proper mechanical exhaust devices and by proper covering for the hands and other parts of the body coming in contact with solutions or salts of mercury. The use of sweat baths at frequent intervals seems effective. Potassium iodide is of value to those suffering from poisoning. Astringent solutions are of service in curing the stomatitis, which under such treatment lasts for a varying period of time. In those who have severe tremors for any length of time the removal of this symptom is virtually impossible.

Poisons Encountered in Munition Works.—Nitrous Fumes.—In connection with the manufacture of explosives a large number of cases of fume poisoning have been reported. These are frequently unrecognized. These cases of "fume poisoning" result from the inhalation of fumes arising from nitric or mixed acids either in the ordinary course of work or when there is an accidental flowing over, the immediate cause of the condition being nitric peroxide.

Pathology.—The effect seems to be due to the corrosive action of these fumes upon the mucous membranes, according to Dr. W. G. Hudson, who has had exceptional opportunity to study this condition. This corrosive action is particularly marked in those who breathe in deeply in the presence of such fumes and may result very rapidly, or after the lapse of a number of hours, in a marked edema of the lungs. When pulmonary edema does not set in immediately the condition

may give rise to a massive or lobar pneumonia whose severity depends upon other complicating conditions.

Symptoms.—The fumes cause coughing, soreness in the upper respiratory tract and after several hours or several days weakness and dyspnea follow, being accompanied sometimes by very severe abdominal cramps. The dyspnea is the most marked symptom and bloody sputum may be expectorated, the case terminating in pulmonary edema. This is a typical picture of acute nitrous fume poisoning. Unlike the fumes of ammonia and other sharply irritant gases nitrous fumes do not cause spasm of the glottis. The various forms of lobar pneumonia are apparently encountered when the fumes have penetrated into the terminal bronchi and alveoli. The outcome of the case depends upon the amount of lung tissue that has been affected by the corrosive action of the fumes.

Preventive Measures.—Oxygen and air helmets and ammonium carbonate sprays are in use either as preventive measures, or for the neutralization of the fumes, or support of the patient after he has been subjected to the fumes. Shallow breathing in the presence of fumes is of the utmost importance as a preventive. Workers are advised to breathe through respirators which are provided with a sponge moistened with a saturated solution of washing soda (sodium carbonate). The administration of 15 drops of chloroform thoroughly shaken up in half a glass of water taken at one time or in small sips over an hour is highly recommended by Hudson. It certainly seems to give relief from the effects of bronchial spasm and abdominal cramps. Hudson found that the combination of 15 drops of chloroform, 1 tablespoonful of aromatic spirit of ammonia and about $\frac{3}{4}$ glass of water, thoroughly shaken, and taken in small portions in one-half to one hour, has an even better effect. The inhalation of this mixture seems to be of some value. The oil spray used with a powerful nebulizer working under sufficient air-pressure to reach the smaller bronchi has given excellent results. Liquid albolin containing a small amount of thymol and menthol is of value as a spray. These recommendations are based on the reports of Dr. W. G. Hudson.

Nitro-aromatic Poisons.—Hudson, ignoring a classification based strictly on chemical composition, includes under nitro-aromatic poisons, di-nitro-benzol, tri-nitro-benzol, mono-di- and tri-nitro-toluol and nitro-naphthaline. These poisons have come into great importance in the manufacture of the newer explosives. Of these, TNT, or tri-nitro-toluol, has received perhaps the most attention. The higher the nitration of these products, in other words the more NO_2 radicals they contains, the more dangerous they are to the workers, so that tri-nitro-toluol is very much more dangerous than mono-nitro-toluol, etc. As Hudson points out, while these are nitro-aromatic bodies, they do not behave like nitrites or nitrates but exert an effect peculiarly their own.

Pathology.—The poisonous action of these agents is chiefly exerted upon the blood. They seem to produce a relative lymphocytosis,

with a considerable reduction in the number of polymorphonuclear leukocytes. The red cells undergo changes in size and form. They become granular, crenated and broken up. The chief change upon the blood is noted in a marked deepening of the patient's color.

Symptoms.—In *acute poisoning* from these various nitro-aromatic compounds, there are present digestive disturbances which may merely amount to a distaste for food or pains in the abdominal area, which are usually accompanied by a fairly severe headache. Marked weakness together with dizziness and restlessness and a disinclination or inability to carry on work are the chief symptoms. These are soon followed by cyanosis with a certain amount of temperature, which is apparently due to the large amount of hematin which is set free in the blood by the destructive action of the poison.

Chronic Poisoning.—The more usual form of poisoning is a slow, chronic intoxication which may also show itself in the form of slight digestive disturbances, nausea, or loss of appetite, a slight headache and weakness, and dizziness. The patient feels increasingly weak and unable to work and, as Hudson describes it, they speak of feeling "down and out." Jaundice which is usually slight at the beginning appears upon the skin, the patient also complains of constipation, and the urine becomes quite dark in color. A progressive asthenia develops. Unless the patient is early removed from contact with the poisonous agent, jaundice deepens, vomiting may become uncontrollable, and the patient dies of a condition which closely resembles acute yellow atrophy. After death, it is found that the blood, the liver, the kidneys and the heart have borne the brunt of the trouble.

In the loading of shells in munition factories, the tri-nitro-toluol must be melted, and the fumes of a given dose of this as well as other nitro-aromatic bodies seem to be more poisonous than the same dose swallowed or absorbed through the skin. In hot weather, poisoning from the nitro-aromatic bodies is particularly frequent. They seem to act more powerfully in smaller doses because of their comparative insolubility in the stomach and their cumulative action upon the blood, heart, liver and kidneys. Dr. Hudson has been able to prevent many cases of nitro-aromatic poisoning by periodic examination of the blood of persons who are exposed. As soon as they show a lymphocytosis of 30 per cent. or over, or changes in the red blood cells, they are shifted to another department and thus removed from further contact with the poison.

Treatment.—The treatment of poisoning with nitro-aromatic substances is largely preventive. Those who are poisoned with these compounds are removed into the open air, stripped of all clothing, and their skin is thoroughly cleaned by scrubbing with a mixture of soap and coarse sand. Alcohol should not be given as a stimulant, ammonia preparations being used for the purpose. Sulphate of soda in the effervescent form is said to be effective for the nausea which is a prominent symptom in acute cases. The bowels are emptied and the drinking of large quantities of water is encouraged. There is no

specific treatment for the more marked clinical conditions which are found as the result of chronic poisoning. The preventive treatment of poisoning by the nitro-aromatic bodies is dependent upon a very carefully devised system of ventilation and methods of dust and fume prevention and removal. This system of ventilation must provide for the removal of fumes resulting from the melting or remelting of substances like tri-nitro-toluol, and, it must also introduce air in abundant quantities into the workroom without raising chemical dust when these poisonous compounds are handled in dry or granular form, or when they are being chipped or otherwise pulverized. The liberal use of exhaust vents placed in the floor or tables, to draw these fumes downward and away from the nostrils of the workers, are among the expedients which may be of service.

Acid Burns.—Acid burns cause frequent and serious accidents in munition plants. All parts of the body which have been injured by contact with concentrated nitric, sulphuric or other acid, should be immediately flooded or bathed with large amounts of cold water. When burns have been produced by acids which have penetrated clothing, particular care should be taken to have those parts lying underneath bathed by allowing a stream of water to flow inside of the clothing. Immediately after bathing the parts, the acid which may have penetrated below the surface of the skin should be neutralized by bathing with a saturated solution of sodium bicarbonate until all foaming has stopped. The subsequent treatment of the burn with paraffin or with various ointments is exactly as in the case of other burns.

Explosives Derived from Analin.—A number of explosives derived from analin have been manufactured of late but their symptoms are like those produced by the nitro-aromatic group, largely related to disturbances of the blood, and a general depressing action. They produce cyanosis, weakness and dizziness particularly, and as a group have much in common with analin poisoning, as one would naturally expect. Like analin poisoning, these compounds of analin are readily absorbed through the skin. They do not, however, produce any destructive effect upon the red blood cells as is the case with the nitro-aromatic group. A diagnostic point of great importance which is emphasized by all those who manufacture products into which analin enters, is the very frequent examination of the blood of workers who are engaged in this work, to discover a reduction in the percentage of hemoglobin. This is held to be one of the most prominent symptoms of beginning poisoning. In connection with the manufacture of explosives derived from analin, poisoning by benzol and toluol must be considered since a large part of the analin is produced from these substances.

Treatment.—In the treatment as well as the prevention of poisoning from the analin explosive compounds, cleansing of the skin is of the greatest importance, and for this, not only soap and sand, but diluted acetic acid or vinegar is found to be of service. The use of atropin and

oxygen have been found to be quite effective when poisoning has developed.

Local Irritant Effects of Modern Explosives.—Following the classification laid down by Hudson, a number of chemical substances which enter in the manufacture of explosive compounds, or some of these explosive compounds themselves, produce local irritant effects. Some of these belong to the two groups already considered. Phenol or picric acid derivatives such as, tri-nitro-phenol, di-nitro-phenol, as well as di-nitro-chlor-benzol, tetra-nitro-methyl-analine, are among the more active local irritants. Tri-nitro-toluol in addition to producing poisonous constitutional effects as the result of inhalation and ingestion, may also produce local irritant effects. These agents cause severe itching together with a dermatitis which is similar to that of many other chemical irritants. The eruption may become eczematous, swollen and hot. The exposed parts of the body are not the only ones affected in this condition. Secondary infection may supervene. They respond fairly readily to the usual forms of treatment for irritant conditions from any cause.

Fulminate of mercury is practically negligible as a constitutional poison, probably because it is manufactured and largely handled outdoors, but it may also act as a skin irritant.

Tetrachlorethane.—Tetrachlorethane is a solvent for cellulose in the manufacture of a varnish for painting aëroplane wings in order to make them watertight. Its effects are essentially the same clinically as those of the nitro-aromatic bodies which we have already considered.

Benzol and amylacetate are also used for the purpose of making solvents in connection with the painting of aëroplane wings.

The occupational diseases here described must suffice to show the scope and range of interest of this new branch of medicine.

THE HYGIENE OF ENVIRONMENT.

Ventilation.—Doctors and welfare managers in industry have proved that bad ventilation causes headache, drowsiness, slowness of mental and muscular action, loss of appetite, pallor, a tendency "to catch cold" and predisposes to the development of infectious diseases. A worker whose vital powers, or "power of resistance" are diminished, is an easy prey to tuberculosis, pneumonia and other diseases.

Ventilation that is effectively provided for in the modern sense, as employed by the sanitary engineer, is by far the most important and health-conserving measure in the entire field of the prevention of occupational diseases. In other words, errors in ventilation are at bottom the cause of the largest number of specific occupational diseases.

A good system of ventilation is one that effectively removes contaminated air as well as dusts, fumes, gases, excessive heat and moisture, and the substances which are generated either as a result of various industrial processes or by the burning of furnaces or various kinds of flames. Moreover, such a system should furnish a clean supply of

air of suitable temperature and moisture, which should be made to circulate freely to *all* parts of the factory quarters. The installation of an expensive ventilating system is not always necessary; it may be even inferior to a simple and inexpensive arrangement. The constuction of the factory, and the arrangement of its equipment so as not to interfere with the circulation of the air are of chief importance; each shop or factory loft has its own peculiarities of shape, size, height, window arrangement, furnishing, equipment and manufacturing needs. There is, therefore, no particular method of ventilation that is equally suitable for all factories.

In certain instances, in order to make an industrial establishment healthful, it may be sufficient to enclose certain dust-producing machinery or portions of such machinery within metallic, air-tight chambers or compartments, or to place metallic hoods over them, through which dusts or fumes may be aspirated and carried away by suction fans, through a system of ducts.

Every factory manager should have his plant carefully inspected, or in lieu of this, he should submit photographs and a detailed sketch of his establishment to a competent sanitary and medical expert in order to secure advice as to the particular kind of devices or arrangements best adapted to the needs of his particular factory. Any single prescription will no more fit all factories, than would a particular medicine cure all forms of disease. A person who has become habituated to a certain type of work and atmosphere is not as keen to perceive defects of ventilation as an outsider who has been trained to observe such conditions. Managers and foremen will repeatedly state that ordinarily they are not aware of certain odors or of other evidences of vitiated air unless they return to business after a long absence, as from a vacation. The man "in the business" may be an expert in the technical side of his work, but he is often unable to detect or to correct sanitary defects obvious to the sanitary or medical inspector.

Natural Ventilation is Best.—Natural ventilation, wherever possible, is best. It requires no mechanical contrivances to bring about a free circulation of air, and when it can be made suitable to the needs of the business and its employees, it is economical because it requires no costly system of supervision or maintenance.

Natural ventilation is obtained through windows, chimney flues, doors, air-shafts, or through any other openings in the ceilings, roofs, walls or floors which may allow the free entrance of out-door air.

There is a variety of devices which may be employed in the construction of a factory establishment, by which natural ventilation may be assisted.

Devices to Assist Natural Ventilation.—Perpendicular holes may be bored through the bottom rail of the upper window. Saw-tooth shaped roofs are frequently seen in foundries and other single-story factory buildings. These consist of a number of windows placed at an angle and projecting above the roof in rows, so that at a distance such roofs resemble the teeth of a saw. Such windows are usually made to

face north, this light being most favorable for work, and allowing for a liberal intake of air. Monitor roofs are also excellent. Globe ventilators are frequently connected with saw-tooth windows. These ventilators are upright metallic tubes set in the roof, with an umbrella-like top beneath which there is a space; as winds sweep across the open space of this tube, a suction is created in the tube by which foul air is withdrawn from the room. This method is employed in theaters. A device which works on the same principle is used to ventilate the sleeping compartments of Pullman cars.

FIG. 81.—Window ventilation is necessary but often insufficient. In this place apparently there is a liberal provision of windows, yet the crowding of employees, and the fumes and dust from manufacture make window ventilation alone insufficient. This is usually true even under very favorable circumstances when the weather is sultry and the air stagnant. (Courtesy of Engineering Magazine.)

Windows, if placed on a central swivel can be hung so as to revolve on a horizontal or vertical axis; thus the entire window space can be utilized to admit air at a given time. The same result can be obtained by French casement windows, which, constructed like doors, can be swung open or closed, as desired.

Small electric fans or large wooden blade ceiling fans (Fig. 82), such as are now familiar in offices, are of value in places where the air may become stagnant, in imparting a certain amount of movement or agita-

FIG. 82.—A desirable measure where a better method of ventilation is not available. A fan placed in the window assures some circulation at least. (Courtesy of Engineering Magazine.)

FIG. 83.—Even a crude way of moving the air in a work shop pays. The uneconomical and inadequate method of ventilation shown in this picture helps somewhat. The method that is coming to be generally recognized is to use a blower and exhaust system which introduces a sufficient quantity of clean air that is warmed in winter and cooled in summer, and which removes the vitiated air. (Courtesy of Engineering Magazine.)

tion to the air within the room (Fig. 83) which is essential for comfort and health.

Unfortunately, many of these devices are ineffective because there is frequent conflict between employees who work in the center of a loft and those who are placed at or near windows; the former wish to have windows kept open and the latter usually insist upon closing them, especially in cold weather because of exposure to cold currents of air.

Elimination of Dust.—There are certain industries, like mirror-making, in which special processes are carried on which demand the exclusion of dust; for this reason, windows are always kept closed in such factories. A fine wire mesh may make it possible to keep the windows open for purposes of ventilation, without admitting dust. In such industries, devices for supplying air that has been filtered of dust and regulated as to temperature, are of urgent necessity.

Drafts Are Dangerous.—As a rule, ventilation is found defective when it is insufficient; at other times, however, it may be at fault because of excessive drafts. These may make it difficult to heat premises economically; moreover, there is a grave menace to health in drafts; they may cause stiffness of muscles and joints as well as predispose to respiratory diseases. If currents of air enter a room so that they strike employees with full force, the latter will almost always close up the inlets; therefore the mere provision of windows and fans without protective devices to prevent discomfort from drafts is not sufficient.

In certain bakeries, for instance, the men and women employed near the ovens where the temperature is quite high, must pass from overheated rooms through windy and exposed corridors to reach other departments or to get to the dressing rooms and toilets, thus needlessly running the risk of contracting disease, especially during the colder seasons. Toilets, too, are frequently quite chilly or exposed to drafts. Likewise, men in steel foundries must often pass from one extreme of temperature to another in the course of their work, or when they obtain a period of rest from their excessive exertions and exposure to great heat.

In still other factories—those which have been adapted to purposes for which structurally they were not intended—work must be carried on near elevator shafts, doorways, or passages which are almost continually swept by powerful drafts. This condition constitutes a decided hazard to health. Revolving doors, or two sets of doors placed at a proper distance from each other, so as to form a vestibule or special corridor, may solve these difficulties.

On the other hand, it is well to remember that warm, vitiated air rises to the upper part of a room and forms an almost distinct layer or stratum of air down to the level of the top of the doors, windows or other outlets. It is therefore disagreeable and harmful to work near the ceiling or on ladders, as painters do, or on balconies, as clerks and others frequently have to, unless an effective method of removing such vitiated air in the upper levels of rooms is employed.

These are some of the problems which engage attention in many

industries. Means for keeping air in circulation or of overcoming excessive heat, cold, moisture or dryness or severe drafts are generally either totally ignored or imperfectly devised.

Cases in which Natural Ventilation is Unsatisfactory.—There may be a number of conditions under which natural ventilation may be ineffective:

1. This occurs when workrooms are very irregular in shape, so that air currents can reach certain spots, if at all, only by turning corners; or, when the arrangement of partitions, or the piling up of materials or of stock, creates enclosed spaces or "dead" areas, into which air currents can enter only with difficulty. This is one of the most common conditions encountered in factories, and in mercantile workrooms particularly.

FIG. 84. — This shows the old method of fur beating in which bamboo sticks are employed and which creates considerable amounts of noxious dust. (Popular Science Monthly.)

2. Natural ventilation may fail when the kind of dust which is generated in certain types of work is very considerable in volume and weight. This is exemplified in metal grinding, polishing, sandblasting and tumbling.

3. When the process of manufacture gives rise to poisonous gases, dusts or fumes in a workroom it is necessary that they be carried away by specially contrived devices before they can be diffused in the air of the workroom to be inhaled by workers, in order to avoid injury to health. This is illustrated in the fumes which arise from the lead pots of linotype machines in printing shops, in the machinery of shoe

factories and in cleaning establishments where naphtha is used (Fig. 84). Fig. 85 shows a dust-removal device which is suggestive of a method of eliminating noxious dust which, in principle, may be widely applied.

4. Where excessively high temperature exists (as in foundries and bakeries), or where there is excessive moisture in the air (as in laundries and sausage factories), natural ventilation is, as a rule, inadequate.

5. And, finally, when natural air currents may have to be excluded because of the character of the work, as in furniture or automobile varnishing, where the entrance of air causes such rapid drying that streaks are left by each application of the brush. In gold-leaf laying natural air currents also interfere with the work, and also in mirror making it is necessary to prevent dust in the air falling upon the unfinished glass surface, through the use of special ventilating devices.

FIG. 85. — This shows a vacuum device in which a motor causes a bamboo rod to oscillate vigorously about one thousand times per minute. The contrivance can be moved about on an overhead trolley and for practically all skins it replaces the oldfashioned bamboo stick beater and eliminates dust hazards. This device was adopted by a number of fur manufacturers upon the writer's suggestion. (Popular Science Monthly.)

Natural ventilation cannot be depended upon because of the capriciousness of air currents, which in large lofts especially makes window ventilation most uncertain.

Natural ventilation may be unsatisfactory also, because in our climate, atmospheric conditions are so extremely variable, that a system effective during the winter months may be absolutely useless during the warmer season.

The Three Methods of Mechanical Ventilation.—When any of the above conditions exist and make methods of natural ventilation insufficient

or ineffective, resort must be had to mechanical devices. Moreover, with a mechanical system of ventilation it is possible to keep the temperature and moisture of the air under control, and the air may be heated or cooled, and washed free or filtered of dust, before it is allowed to enter the workrooms. There are essentially three types of mechanical ventilating devices which are the foundation of all mechanical systems, however complicated such systems may appear.

1. There is the plenum or blower method, by which a fan of *adequate power* blows or propels air into a given room or space (Fig. 86). The air current created by such a fan may be discharged directly into a room or be conducted through metal tubes or ducts of carefully *calculated diameter* which end in branches and finally discharge an air supply at selected points. In the use of this system a word of caution is necessary. When the points at which branch tubes discharge their air currents are

FIG. 86.—Hollow column air-distributing system in the Ford shops. Through this system, ventilation, cooling and heating are carried on. (Courtesy of American Blower Company.)

unwisely selected they may be either inadequate to ventilate the room, or they may direct chilling drafts upon the workers, thus interfering with their work; under the latter circumstances employees will, as already mentioned, find ways of shutting off the supply of air and make the system ineffective (Fig. 87).

2. The vacuum or exhaust method of mechanical ventilation is one which depends on a fan that creates suction through a system of metal ducts or tubes, and extracts air that is impure, dust-laden, or charged with fumes or gases, and discharges such fumes outside the room or building. Contaminated air that is exhausted in this way may be collected or cleaned in specially devised chambers, and if the dust that is recovered in this process is of value a source of income may be derived from material that would otherwise be wasted; in certain industries this is a very important consideration. The vacuum or exhaust method should be so adjusted to machinery that any con-

taminating substances that are generated in the process of manufacture are completely and immediately withdrawn at the point where they arise, thus preventing their dispersion into the air of the workroom. Too frequently the collecting tubes which are placed over machinery or other factory equipment, and which are intended to carry off or exhaust dust, gases or fumes, are placed at such a distance from the point where such contaminating substances are produced that they must be inhaled by the workers before they can reach the collecting tubes (Fig. 87).

FIG. 87.—Drying room of the Universal Film Company. Note the risers from the floor through which air of proper temperature is blown into the room. (Courtesy of American Blower Company.)

3. The third method is the balance system, a combination of blower and vacuum. Air is forced into the room through one set of tubes and extracted through another set. Wherever the rooms to be ventilated are very large this is a particularly valuable method. The inlet or opening through which air is expelled must be carefully constructed and placed, otherwise an expensive installation may be rendered absolutely worthless.

A technical adviser is the best judge as to the proper method to employ. His special knowledge enables him to ventilate a rathskeller or a subbasement, as effectively as a modern loft, restaurant, or the main floor of a department store. When a mechanical method of ventilation fails, it is due either to poor judgment in regulating the power or the placing of fans, or in the diameter of the conducting tubes and the points at which they discharge air. Expert advice as to the engineering data for the installation of such devices is in the end a great economy.

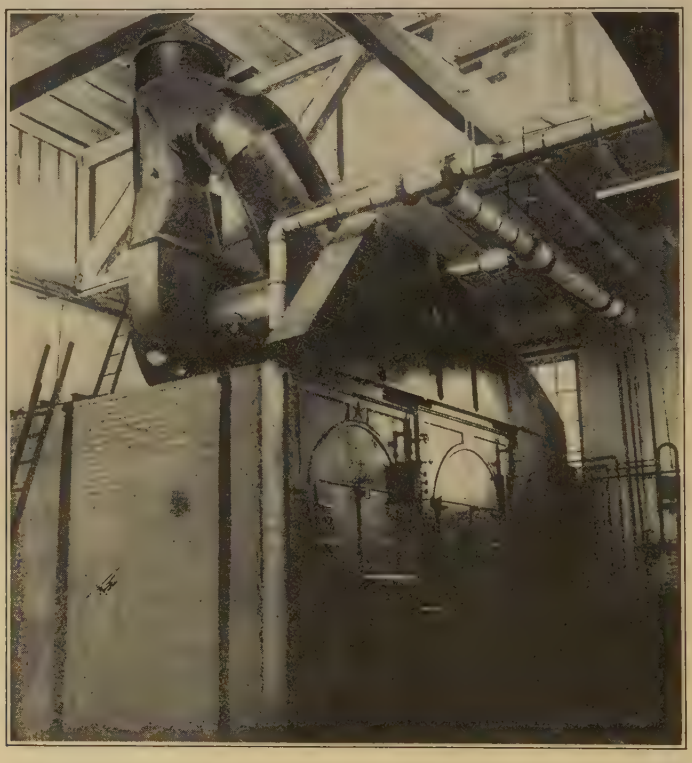

FIG. 88.—A boiler room of unusual character. In boiler rooms, as a rule, no attempt is made to provide comfortable working conditions. In this picture is shown a boiler where the excessive heat is exhausted through a hood, making the boiler room comfortable. The heated air which is exhausted through a system of ducts can be utilized for heating the factory plant, after being filtered and sufficiently moistened. (Courtesy of Engineering Magazine.)

The subject of ventilation in relation to the occupational disease is too extensive to be dealt with at greater length in this section, and, as its importance warrants.

Heating.—A good heating system in a factory or workplace is intimately related to the problem of ventilation. The temperature of the workplace influences the health, comfort and efficiency of workers. A heating system may be costly and yet fail to accomplish its purpose. The sanitary engineer who is truly expert in installing a ventilating

system is not content merely to provide exhaust and blower fans, but must often given attention as well to the temperature of the air which is forced into the workplace, to provide a proper percentage of moisture and freedom from dust and fumes.

Heating by stoves is uneconomical, and, as a rule, ineffective in large establishments. Hot water, which is a waste product in many industries, has been utilized for heating by being made to circulate through radiator coils placed throughout a building; it is not as practical and economical a method as steam-heating. The distribution of heat in a building is readily taken care of by any competent sanitary engineer. Too many establishments are overheated; this defect is often as bad in its results as is a lack of heat. Overheating causes fatigue, headache and discomfort; it lowers health and conduces to accidents. Extreme heat may cause heat-exhaustion, joint and muscular pains, choleraic symptoms, and predispose to disease. The air in offices and factories is often allowed to become so much drier than the outdoor air that the employees who pass from one to the other are frequently affected with catarrhal conditions and other diseases of the nose, throat and air passages.

When heat is extreme screens of asbestos or other material interposed between workers and the furnaces at which they work may lessen the heat very considerably. Forced air blasts may also help to lower the temperature of a shop.

How to Light a Factory.—A good system of lighting is more than a matter of mere comfort. It frequently prevents accidents and increases the efficiency of workers, especially when they are engaged in delicate manipulations or work that requires close application; it also does away with headache, dizziness, general sluggishness, inflammation of the eyes, fatigue and nervous symptoms and the other ill effects of eye-strain. Engravers, type-setters, weavers, lamp-testers, diamond-cutters, proofreaders, etc., are notoriously subject to eye-strain and often suffer permanent injury to sight.

Lights may be objectionable either because they are too dim, or excessively bright and glaring (Figs. 89, 90). Lighting, like ventilation, is best when it is natural. Modern methods of steel and concrete construction make it possible to utilize 80 or even 90 per cent. of the total wall surface of a building for windows. With the old method of brick and wood construction, and with wooden window frames, this was impossible; nevertheless, even in buildings of the latter sort about 50 per cent. of the wall surface can and should be devoted to window space. With the marked variations in the length of days during the different seasons of the year, natural lighting cannot be exclusively depended upon, no matter how well provided.

Skylights, and more especially saw-tooth roofs, permit a maximum amount of light to enter the workplace. They can of necessity be constructed only on single-floor buildings or on the top floor of a high building.

When a loft is very deep and wide it may be poorly lighted in the

center despite numerous windows; in such a case, work requiring close attention and bright illumination, as in jewelry-making, should not be attempted in the center of the loft unless well-shaded artificial lights

FIG. 89.—Pupil contracted in a bright light. Muscles of eye also contracted. This constant cramp-like contraction of muscles of the eye causes fatigue and eye-strain and conduce to accidents. (Courtesy of New York Edison Co.)

FIG. 90.—In moderated and well-shaded light the pupil is not contracted.

of sufficient illuminating power are supplied. Windows must be clean to prevent obstruction to the entrance of light. If a building is crowded in between other buildings it may be impossible to properly illuminate its lower floors especially, without resort to artificial lighting. A light

FIG. 91.—Each of these little rooms receives the same amount of light. On the left, the dark walls absorb most of the rays; on the right, the light-colored walls reflect the rays of light causing a most marked contrast. (Courtesy of New York Edison Co.)

coat of paint on the walls of adjoining buildings improves natural lighting. Walls and ceilings inside of factory buildings should especially be painted with light colors,—a light green or tan,—and kept

clean (Fig. 91). It is important to prevent a strong glare, whether natural or artificial light is employed (Figs. 92, 93).

FIG. 92.—A bright light that is not shaded shines directly into the eyes and causes fatigue and accident. (Courtesy of New York Edison Co.)

FIG. 93.—A shade protecting the eyes from the bare light. (Courtesy of New York Edison Company.)

Arrangement and Construction of Windows.—To prevent the glare that results when the sun shines directly into a loft, either the use of window shades or of frosted, ribbed, or other transluscent glass may be necessary to subdue the light. Windows should extend upward as near the ceiling as possible. Stock, machines, and equipment should, if

possible, be arranged so as to interfere as little as practicable with natural light. The lower panes should be transparent, as it is restful and relieves the strain upon the ocular muscles of workers to look out into the distance occasionally. The larger the window panes the smaller the ratio of obstructing framework is. Often the very factory managers who pride themselves on their attention to details with reference to factory lighting permit gross defects to exist owing to a lack of proper understanding of the essentials of good lighting.

In some offices the clerical force is frequently seen engaged in work that is trying to the eyes, and yet the desks are placed in the center of a very large floor at a distance from the source of light, or else the workers directly face the light, thus suffering from the results of the glare; in still other cases the employees are so seated that their bodies intercept the light. It is best to have light coming from only two sides of a room, and those opposite each other, except when the depth of a loft is excessive. Working in the dark or in very dim light is harmful; its extreme ill-effects are seen in miners, who frequently develop nystagmus, or "dancing pupils;" a condition in which the eyeball oscillates rapidly from side to side. The latest studies seem to indicate that a constrained posture which requires an upward turning of the eyes while at work adds its influence to the effect of dim lights to produce nystagmus. The effect upon the eyes and nervous system of girls who work for long periods in a dim red light packing photograph films, or upon employees in moving-picture theaters, may ultimately be very harmful.

Excessively Bright Lights.—When artificial lights are too brilliant they should be shaded so that the light falls upon the work; especially should one avoid placing such lights on a level with the worker's eyes, causing it to shine directly into the eyes, thus inducing fatigue and creating a liability to accident.

In an investigation of a block of office buildings that was conducted by the New York City Department of Health in one of the busiest sections of the financial district of New York City, it was found that somewhat over 85 per cent. of 2382 persons employed in the offices in this block were compelled to use artificial light in their every-day work, and in many instances in the middle of the day. Usually the lights were placed at too great a distance from the desks or typewriters, or they were too dim. In other cases excessively bright lights were placed very close to the work desk and caused a glare, or a too highly polished desk caused such a glare, or a shade of improper style was employed. On the basis of this investigation it was recommended that in addition to ceiling lights, desk lights of low candle-power should be provided and placed at a distance of not over nineteen inches and at an angle of 45 degrees to the left of the field of work in the case of right-handed persons.

Parts of machinery having glistening or polished surfaces which keep moving continually before the eyes of the employees constitute a source of eye-strain, fatigue and nerve-strain; this applies with equal force

to the handling of materials which have a high gloss or polish. Such conditions impair efficiency and conduce to accidents.

In foundries, and where electric welding with the oxyacetylene flame is done, a brilliant light is produced; the eyes should be protected from such light by wearing amber or natural-tinted glasses.

Safety goggles, of which there are a large variety on the market, are very effective, and are absolutely necessary in certain occupations such as electric-welding, furnace work, or wherever excessively bright light from electric flashes or any other source may exist, because they prevent irritation and inflammation of the eyes as well as injuries from flying particles (Figs. 94, 95).

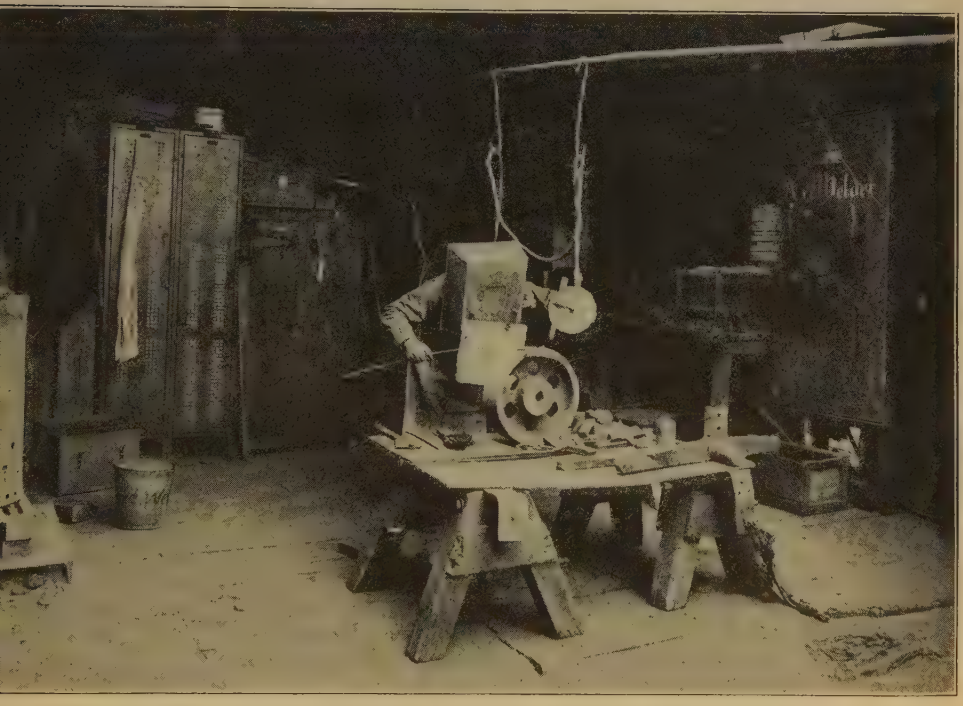

FIG. 94.—Head mask for protection from sparks and blinding glare in electric-welding. (Courtesy of U. S. Steel Corporation.)

Goggles should be light, allowing no metal parts to touch the skin, and be re-enforced so as to protect the eye in case the glass is broken. They should be constructed with lateral guards that will allow a wide field to be seen and yet prevent flying particles of any sort to enter the eye from the sides (Fig. 96).

While it is not strictly relevant to the question of lighting, it may not be amiss at this point to call attention to the fact that physicians who have studied the eyes of employees engaged in grinding, polishing, and buffing, report that the shower of fine metal or mineral particles against the highly sensitive, transparent cornea continued for months

or years, causes very numerous pinpoint scars; these can be readily observed with a magnifying glass. Such scars reduce the sharpness of vision down to 50 per cent. or even 5 per cent. of the normal.

A very large percentage of eye injuries that lead to serious impairment of vision and even to blindness, are the result of failure to provide and wear safety goggles. The foreign bodies that lodge in the eye set up frequently a dangerous inflammation; the attempts of fellow-workers to remove them from each other's eyes have frequently produced infections that have resulted in blindness. Only a physician should be permitted to treat even the slightest eye injuries and remove foreign bodies. Delay in securing skilled help frequently causes permanent damage. Injuries to the eyes are probably the most common industrial accident.

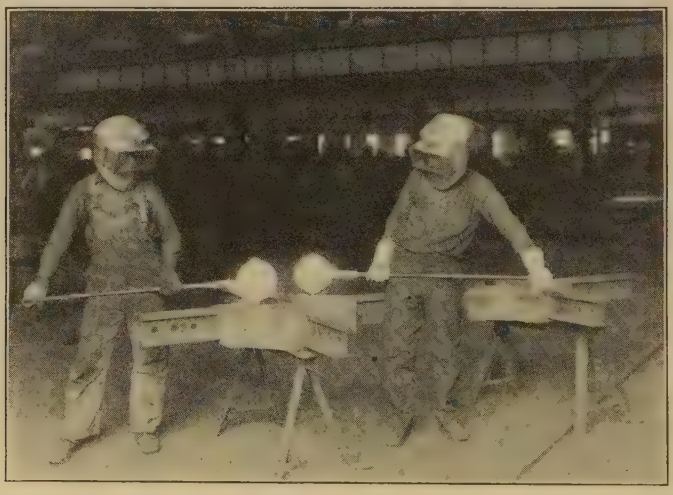

FIG. 95.—Head masks worn while babbitting in steel works. (Courtesy of U. S. Steel Corporation.)

A near-sighted employee, whose defect is not corrected by properly fitted glasses invites accidents; he is compelled to bring his face too close to his work, and is in greater danger than persons of normal vision of inhaling poisonous dusts, gases or fumes, if these are associated with his occupation.

Paint and Cleanliness Help Lighting.—Natural and artificial lighting are very much aided by painting the walls, ceilings, and equipment, so far as possible, a dull white, a light tan, or a greenish-gray color. Surfaces having enamel finish cause reflections that fatigue the eye.

Abundant light, and walls painted in light color, make dirt so conspicuous that their provision has a natural tendency to produce cleanliness in an establishment. One company in recognition of this fact has caused every corner in its buildings to be painted white; it reports that, as a result, there has been a marked improvement in cleanliness; the

workers are not so apt to expectorate or to throw waste matter in corners which are well lighted.

Facts as to Artificial Lighting.—In installing artificial lighting systems, much depends upon the type of light which is employed, its intensity, proper shading, and upon its being placed at a proper level. Attention

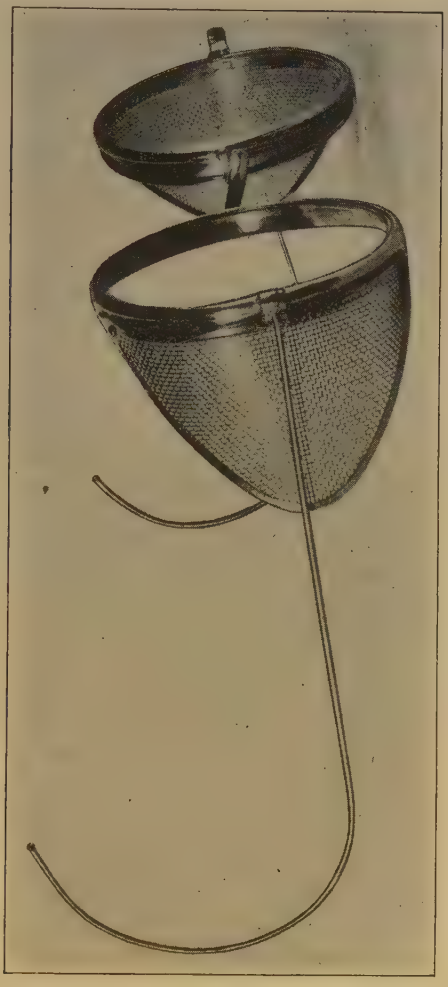

FIG. 96.—Goggles to protect eyes from flying chips and dust. (Courtesy of U. S. Steel Corporation.)

to each of these details is of great importance. For instance, a light may be so shaded, and placed at such a level with relation to the eyes of workers as to eliminate a glare, but may be too dim and give off excessive heat—a gaslight for example. Or, again, lights may be bright enough and well shaded, but placed in such bad position that the bene-

ficial effect is lost and an otherwise adequate light is dissipated, so that the workbench or desk is left in comparative darkness.

Lights should be so adjusted that pronounced shadows are eliminated; where shadows are produced the quality of work is interfered with, eye-strain is favored and accidents from tripping or from failure of rapid accommodation of the pupils to changed conditions of lighting may occur. Green, blue or violet mercury lamps, such as are used by photographers and others, are usually unpleasant and irritating to the eyes, because the most active and powerful rays of light—the actinic rays—are here utilized. Such lamps are of service only in work which requires very close scrutiny. Electric lights, especially tungsten lamps are, generally speaking, the most practical. Incandescent gas mantles give a bright white light, which requires careful shading, but when used in large numbers they are objectionable because of the heat and gases of combustion that they generate; when this is the case, special care should be given to ventilation.

Artificial lights are usually placed near the ceiling, so as to illuminate the workroom in general, and additional lights are adjusted close to machines and at special points so as to give a maximum amount of light where it is most needed. To secure general illumination of a workroom, artificial lights, especially powerful tungsten lamps (100 to 1000 watt) should be dispersed in sufficient number at carefully estimated distances from each other, near the ceiling. No general rule for the adjustment and disposition of lights can be given that is applicable to establishments that vary greatly in their constructive and other features; each problem must receive individual attention.

Lights that are placed close to machines or to workbenches give what is known as "local" in contradistinction to "general" illumination. It may be stated, as a general rule, that no factory or office should depend upon either "local" or "general" illumination alone; it is best to combine the two. A "general" system of lighting usually fails to provide illumination sufficiently bright for work that requires care and close observation. On the other hand if only local lights are employed and placed at selected points near machinery or workbenches, the rest of the room is left relatively dark, and employees may be dazed in attempting to move about, and as a result accidents may occur.

When ceilings and walls are painted white or in other light colors, a white enameled metal or other opaque bowl placed beneath a ceiling light reflects such light upward upon the ceiling and is diffused over the space beneath; this is known as indirect lighting. If instead of a metal bowl or reflector, a translucent glass bowl is employed, the light in part passes through the bowl, and in part it is reflected to the ceiling and thence diffused; this is known as "semi-indirect" lighting. Both the indirect and the semi-indirect methods of lighting are excellent for general illumination, both prevent fatigue and eye-strain, but the semi-indirect method, while not quite as restful as the indirect, is more economical.

Washing Facilities.—Personal Cleanliness.—When working people handle poisonous metals, liquids or chemicals, as, for example, lead, arsenic, mercury or anilin dyes, or infectious materials, washing facilities should be adequate, and *hot water*, soap and brushes should be provided. Signs printed in the language best understood by the workers should be conspicuously posted, to give warning of the dangers that are connected with the work, unless strict cleanliness is maintained. Those employees who handle dangerous chemical substances should be given a ten or fifteen-minute period deducted from factory time, to wash befor eating lunch and before going to their homes at the end of their day's work. If the time is deducted from their lunch period, or, if the number of faucets or other facilities available for washing purposes are inadequate, employees will, as a rule, fail to wash.

FIG. 97.—Shower baths and wash basins in room warmed by radiators. Note the plunge in center. (Courtesy of U. S. Steel Corporation.)

These rules hold equally true as to the use of shower baths. In trades in which dangerous dusts exist, and in any trade where the worker gets very hot or very dirty, shower baths are of the greatest value in removing poisonous or irritating dusts from the hair and skin, and are therefore a protection to health and an economy to the business in the long run. Baths are splendid tonics to those who are fatigued, especially if they are of short duration, and neither too warm nor too cool. Workers will abstain from the use of baths if the temperature of the water is too low; moreover, cold water is never as effective as warm water in cleansing the skin. It should be borne in mind that employees ignore any welfare measure which in any way causes discomfort or a loss of time. A worker who enjoys the tonic and cleansing effects of a bath is more likely than otherwise to be alert to cleanliness in the home.

In occupations in which dangerous dusts or chemicals are encoun-

tered, washing should not be left to the option of the employee but should be enforced by a foreman or other supervisor, who should be held responsible for compliance with this most essential regulation.

In addition to those requirements, which have already been alluded to, care must be exercised that the floors of shower baths are not too cold or slippery; for this purpose, wooden grids or rubber mats should be employed, and they will be found to add not only to the comfort of employees but to prevent accidents from slipping as well. The floors of shower baths should be constructed of some impervious material, properly graded and drained, to prevent accumulation of water.

Soap is essential for washing, and receptacles for powdered or liquid soap, of which many kinds are sold, will be found to be the most practical, sanitary and economical.

When troughs are provided for washing purposes the drain-pipe opening should never be plugged, so as to prevent filling of the trough with consequent transmission of disease from worker to worker, as a result of washing in standing water used in common by a number. A wire-mesh screen should be fastened about four inches above the bottom of the trough to prevent the use of standing water (Fig. 97).

Lockers for Clothes.—Lockers are not luxuries but a necessity to people who are employed in an atmosphere heavily charged with odors or with poisonous dust or chemicals that may adhere to the clothing. Lockers should be provided so that employees may be able to change their street clothes for special work-clothes or overalls. The locker facilities must be such that the street clothes should not be soiled or contaminated by contact with the work-clothes; for this reason, in trades which are especially characterized by dust, dirt or fumes, separate compartments should, if possible, be provided in each locker for the two sets of clothing. Arrangements which provide for the keeping of separate wearing apparel save the employees from becoming soiled with the poisons or other harmful substances that they handle and help them to prevent bringing these dangerous agents into their homes.

Cleanliness of lockers and of locker rooms must be strictly maintained. Locker arrangements should not be installed in workrooms if possible; they should be placed outside the workroom, where the clothes will not be covered with trade dust. Locker rooms should be well lighted and well ventilated; light and air in abundance are in this case, as in all others, among the best germ destroyers that we have. If hooks only are provided for hanging up clothes, they should be so placed that the clothes on adjoining hooks will not touch. It is a frequent practice to place hooks on opposite sides of a beam or board, so that clothes of different persons are in contact; where wardrobe space is limited and economy is essential, two parallel cross boards, at least six to eight inches apart, will allow the placing of hooks so that a safe distance will be maintained between clothes on opposite sides.

To help the drying of street clothes on rainy days, steam pipes placed around the walls or close to the lockers are very effective. This frequently prevents disablement of employees from colds, pneu-

monia, etc., especially when, in addition to these, facilities for drying wet shoes and socks or stockings are provided. In a number of factories the provision of dry socks and stockings and of umbrellas has greatly assisted in preventing sickness resulting from exposure to rain and snow.

A locker which is most sanitary and in the long run most economical is one made in the form of a small steel closet, with slits or perforations which allow for ventilation. Locker rooms should be provided with seats to facilitate dressing and undressing; small folding seats which are kept in the lockers are of service and do not take up additional space. Air-tight lockers are frequently found in use and are undesirable from a sanitary standpoint. In establishments where a number of female employees are at work hats should not be permitted to be placed on top of each other or close together, as is so frequently done; the latter practice has been known to transmit pediculi from one to many employees.

FIG. 98.—The old way of supplying drinking water. A dangerous method. Tuberculosis, syphilis and other infectious diseases are thus transmitted. (Courtesy of U. S. Steel Corporation.)

Drinking Cups and Water Supply.—It is accepted as an axiom that a cup, glass, pitcher, spoon, fork, or similar article, if used in common by two or more persons, may transmit tuberculosis, syphilis or other infectious disease (Fig. 98). This is particularly true of drinking cups. Paper cups for individual use are ideal although expensive. A good solution of this problem is to supply each employee with an aluminum cup at cost price, or, better still, to provide sanitary drinking fountains placed where they are readily accessible (Fig. 99). If the supply of drinking water is placed at a distance from a group of workers, or if for other reasons it is not easily available, the employees will omit to drink the quantity of water which is requisite for health, or else drink

excessive quantities at infrequent periods. A liberal supply of drinking water is of special importance to those whose work is severe and causes profuse perspiration. *A sufficient and good water supply is a health asset.* Moreover, the lack of such water supply frequently stimulates a strong craving for alcoholic drink.

Water should be neither too cold nor too warm. One of the most frequent causes of intestinal trouble in men who work where heat is excessive is the drinking of large quantities of cold water. Water should be cooled by means of a cooler or other refrigerator, or ice be packed around the container. It is unsafe to cool it by placing ice into it; intestinal disorders and typhoid fever have not infrequently been caused in this way. If water is unpalatable, employees will abstain from drinking it. When the source of water supply is known

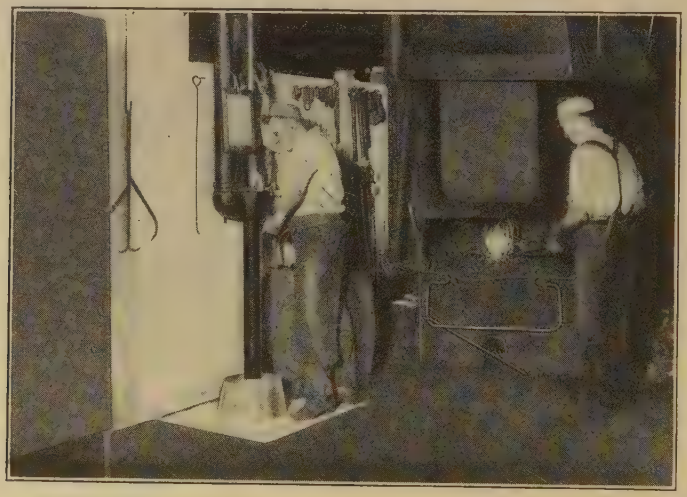

FIG. 99.—Drinking fountain close to the furnace where men can satisfy their thirst readily. Men doing such work as this require an abundant supply of drinking water near at hand. (Courtesy of U. S. Steel Corporation.)

or suspected to be impure, special devices should be installed to purify it. The sanitary drinking fountains provided should be so devised that the water bubbles up high, and so that it is practically impossible for an employee to place his lips against the opening from which the water bubbles. A metal ring or collar is frequently placed in such a position that the lips are kept at a distance from the spout of the fountain. Recent studies have proved that germs may be transmitted from the lips or tongue of an infected person who places them in contact with the spout of the fountain, if the water bubbles up only a short distance under low pressure. These studies have shown that the germs are kept suspended and dancing in the water for several hours. By experiments it was demonstrated in a western university that certain selected varieties of germs could be placed in the spout of water by contact with lips that had been smeared with such germs,

and that the latter were recovered several hours later from the bubbling column of water. It was learned in one instance that a severe epidemic of septic sore-throat, occurred among a group of students who drank from a bubbling fountain which had been used by a person whose lips had touched the spout and who was suffering from this disease. To prevent any infectious matter remaining suspended in a column of bubbling water the spout of the fountain should be so constructed that the water bubbles up at an angle of at least 15 degrees, and so that it falls to a side immediately and is drained off with all its contents.

Towels.—Towels, when used in common, may transmit syphilis, gonorrhea, tuberculosis, trachoma and other diseases. The paper towel, although usually effective, has a limited value for industrial use, because it does not aid in removing dust or dirt that adheres to the face or hands by friction, as the cloth towel frequently does. In addition, the paper towel is relatively very expensive.

Several methods have been devised to overcome the practical difficulties connected with the furnishing of individual towels to employees. In some establishments very satisfactory results have been obtained by having a porter or other employee distribute individual cloth towels to employees two or three times a week. Each employee receives a clean towel only upon returning the one that has been soiled. This method is especially effective if a charge equal to the cost price of a towel is made for failure to return one.

Another satisfactory arrangement is the following: A metal ring is securely attached to one corner of each towel; a sufficient supply of towels for the day's needs is placed on a shelf about four feet above the floor. A steel rod is firmly secured to the shelf at one end and passes perpendicularly upward through the metal rings in each towel, makes a short bend, and then passes downward and is fastened into the floor or wall. When it is desired to use a towel it is lifted from the shelf, drawn along the rod, and after being used it is dropped into a basket on the floor; it is at all times attached to the rod and remains securely fastened until the ends of the rod are unlocked.

Last, a new mechanical device containing a roll of towel cloth that is about twenty-five feet or more in length is now being tried. Each employee is given weekly a certain number of special coins; when a towel is desired one of these coins is dropped into a slot and a sufficient length of towel is released. After use the portion of towel that has been released is mechanically drawn into a special compartment, so that it cannot be used again. Certain mechanical towel rolls of this type are not provided with a device for removing the used portion of the towel-roll; the latter machines make it possible to use over and over again a section of cloth that has previously been drawn from the machine, thus making it in no manner superior to the deservedly condemned roller towel.

To prevent the loss of individual drinking cups and towels that may be supplied to employees, a small drawer having a compartment just large enough to hold these articles and furnished with lock and key

is very useful, if built into the workbench or wall of the workroom. If a drawer of this character is made too large the workers will, as a rule, store their lunches and other undesirable articles in them; lunch packages, above all things should never be taken into workrooms, especially where dusty or chemical processes are carried on.

Toilets.—If toilets are poorly constructed, filthy, or inadequate in number, so that those who wish to use them during rest periods, lunch hours or at other times must wait their turn, or if they are located at a distance from the workroom, employees will avoid their use as much as possible. Such unfavorable conditions with respect to the location and character of toilets may upset the regular physiological habits so essential to the health of employees and lead to chronic constipation. This is illustrated sometimes in the case of girls, who, in order to reach unfavorably situated toilets, may have to pass through lines of male employees; the fear of making their needs conspicuous restrains them from availing themselves of these facilities, with consequent discomfort, and, very likely, ill-health as well. The toilets that are provided should be modern in construction as regards sewer connections, flushing, ventilation and cleanliness; privacy should be assurred those using them. Water-closet apartments for the two sexes should be separate and as far apart as possible. The toilet rooms for each sex should, if possible, be situated in different parts of the building. Where water-closet apartments adjoin, the partitions between them should be sound-proof and of solid construction, so as to ensure privacy and prevent the escape of odors. Toilet compartments should be separately vestibuled and plainly marked, so as to indicate for which sex they are intended. The number of toilets and urinals required for a given number of employees in any establishment, together with specific details as to the materials and construction of floors, sidewalls and partitions, are, as a rule, definitely laid down in the various State labor laws, which should be consulted by employers. In fact the State labor laws will be found to be equally specific as to the number of wash basins and similar comfort facilities that are required in factory buildings.

In moderately large establishments, toilets should, if possible, be situated on every floor; in no case should they be distant from the workroom or otherwise inaccessible. They should not be placed outside the building, nor should they be placed in the middle of a loft unless they are in direct communication with the outer air through air shafts or other means. Toilets must not be made to depend for their ventilation upon openings or windows leading into the workrooms; they should communicate with the outer air by means of windows and be provided with fans or other suitable devices for proper ventilation. Facilities for washing should be immediately adjacent to the toilets, and soap and towels should be provided; also, signs calling attention to the necessity of washing the hands, should be conspicuously placed.

Sweeping and Cleaning of Premises.—The general cleanliness of a business establishment is a fairly reliable index to the healthfulness of

the workplace and of the attitude of the employer or manager toward questions affecting the welfare of employees. Thorough and frequent cleaning of floors, walls, furniture and machinery is conducive to comfort and to health and may be a means of preventing accidents. Keeping windows clean and walls white are also of value as a means of improving lighting. Fire hazards may be considerably diminished by prompt and effective disposal of rubbish, refuse and trade waste. Moreover, general cleanliness affects the tone and character of employees; clean surroundings in the factory tend to create and to confirm habits of cleanliness.

It is improper and may be dangerous to permit sweeping or dusting of the floors, walls and fixtures of a workroom just before the day's work is begun, and still more so during work hours or just before the lunch hour. Sprinkling water on floors, or the use of a damp broom or cloth for sweeping and cleaning, are advisable. There is purchasable in the market a soft broom which has a metal hood attached directly above the brush, and which, if used with damp sawdust or liberal quantities of wet pieces of newspaper, or one of the so-called "dust settlers," is fairly effective in preventing the raising of dust. When the use of a vacuum cleaner is not practicable, a dampener or settler is absolutely essential, because dry sweeping raises dangerous dust, scatters it about and causes a large portion of it to be distributed upon the walls and furniture.

The best method of cleaning and sweeping, in spite of the fact that many protest that it is impractical, is by means of the vacuum cleaner. Already many factories have installed this method, and the time is not far distant when the vacuum method of cleaning will be in well-nigh universal use, effecting safety, and economy as well, in spite of the initial cost. Vacuum suction can be made powerful enough to serve in many industries.

Little attention is usually given to the selection of the person who is to do the dusting and sweeping, and, frequently, one or several boys or girls, or frail individuals who give evidence of susceptibility to tuberculosis, are assigned to the task. The protection of the sweepers and cleaners is an important consideration, and therefore, even if sweeping is done after work hours, a vacuum or dustless method should be employed. While a handkerchief, such as is often worn over the nose and mouth in certain dangerous and dusty occupations, to serve as a mask or respirator, is utterly worthless as protection against poisonous dust, it may be of some service as a protection to sweepers where a better means of protection, namely, a respirator, is not available.

Spitting and Cuspidors.—Spitting should be strictly prohibited in the workroom, as indeed in all public places, because the germs of tuberculosis, pneumonia, influenza and other serious diseases, which even the sputum of healthy persons may contain, are distributed in the air when the sputum dries and is inhaled by those in the workroom. The habit of spitting is particularly common among members of certain trades who *chew* or *smoke* while

at work; such a habit when characteristic of a trade has a three-fold danger: (1) There is the danger to others from the germs in the dried sputum; (2) when spitting is an accompaniment of smoking, a distinct fire hazard exists from lighted cigars, cigarettes and pipes; (3) should the dust about the premises be poisonous, much larger quantities than ordinarily, are likely to be carried into the mouth through smoking or chewing.

Employees usually refuse to expectorate into their handkerchiefs; cuspidors should therefore be placed near the work benches of those who cannot control the spitting habit. A large variety of cuspidors are available. The essential points to be kept in mind in selecting them are the following:

Whatever the material of which they are constructed they should be shaped and and weighted so as not to tip over readily; there should be no angles or sharp corners to make cleaning difficult, and for the same reason the neck of the cuspidors should be wide, and, if possible, they should be constructed of material that has a glazed or enameled finish. Furthermore, they should contain a disinfectant solution of chlorinated lime or a weak carbolic or bichloride of mercury solution. When the use of disinfectant solutions is found impracticable water should be place in the cuspidors. Dry sawdust within or around the cuspidors should never be permitted, as it only hastens the drying of sputum and can readily be blown about. When an employee is persistently careless and expectorates upon the floor, in spite of the fact that cuspidors are provided, he should be warned that he is endangering the health of others. If public-spirited foremen or fellow-workers would be willing to notify health officials of such violations and give legal testimony against such obstinate offenders with whom education and persuasion fail, much could undoubtedly be done to root out the practice.

When cuspidors of suitable character are not provided it is safe to permit workers to expectorate into a properly drained sink which is not employed for washing dishes or in the preparation of foods. Surely, it is no more dangerous to ordinarily expectorate into a sink than to clean one's teeth and to discharge the mouth rinsings into the basin, provided the basin is flushed so as to promptly wash down the sputum. As a matter of fact the French have devised a cuspidor, based on this idea, which is connected with the waste pipe, trapped, and has a flushing system.

Paper cuspidors, with or without metallic holders, can be obtained rather cheaply, and they should be burned after use, thus doing away with the labor and danger of cleaning metal cuspidors. These paper cuspidors are made so as to hold water (water one inch in depth is sufficient). Another excellent type of cuspidor is a shallow iron or steel enameled basin, about ten inches in diameter, with a funnel-shaped removable cover having a large opening in the center; it is better still to dispense with the cover if the cuspidors contain about an inch of water and are cleaned often enough. Cuspidors should be cleaned out of doors, if possible, flushed with a hose and boiling water and the contents drained into a sewer.

Pottery and china cuspidors break readily and are, therefore, too expensive.

Lunch Rooms.—No employee should be permitted to eat lunch in the shop, especially if poisonous dust or chemicals are handled there. Nor should workers be compelled to eat in dark, dirty parts of shops or factories which are too poor to be put to other uses. In the case of male workers it is frequently found even since prohibition has been put into effect, that they resort to the nearest saloon, where they now exist, the meanest of which frequently offers more comfort and cleanliness for lunch purposes, than many workshops. There has been a steady growth in the number of factories and shops which provide rooms especially designed to serve as lunch rooms. When proper care is taken to provide washing facilities, toilets, and lunch rooms, the corner saloon is frequently put out of business. Lunch rooms should have no connection with the workrooms; in other words the small space in the corner of a shop which is more or less curtained off does not answer the purpose of a lunch room and may be a source of danger in certain occupations. This danger has, in fact, been recognized, and legislation exists which compels employers to furnish properly walled-off lunch rooms wherever lead, mercury, arsenic and other dangerous chemicals are used.

Lunch and Rest Periods.—All employees and especially girls should receive a lunch period of an hour. Often the girls themselves request the half-hour luncheon period in order to secure a half-holiday on Saturdays; but to permit this arrangement is a short-sighted policy, especially in the case of employees, male or female, whose labors require severe exertion that is trying to nerves, muscles or eyes, or whose occupation is sedentary. Even if a half-holiday is granted every Saturday throughout the year, the cases of indigestion and nerve-strain resulting from insufficient rest and hastily swallowed meals, will make many employees chronic sufferers. More harm may thus be done workers by an inadequate luncheon period than several years of half-holidays will cure; therefore, under none but exceptional circumstances should the luncheon period be less than an hour.

Rest rooms for workers, especially for girls, are an excellent investment. An increasingly large number of factory owners are recognizing this fact. Where large numbers of girls are employed, the suffering caused by the severe pain of menstrual disorders and by attacks of headache or other illness, compel many of them to discontinue work for the day. It is not only humane, but economical as well, to provide suitable rest rooms where quiet and rest may be obtained by those who become ill; frequently, after a rest of one or two hours, a temporary indisposition may be relieved and the employee may be able to continue work for the rest of the day.

Many companies have found it profitable, from the standpoint of increased efficiency, to allow their employees one or two rest and recreation periods of from fifteen to twenty minutes each day. These periods of rest are particularly valuable when the work is very monotonous and demands keenness of observation, rapidity of movement

or marked physical effort. The quality and quantity of output have been greatly improved by allowing such rest periods, to say nothing of the improved condition of the worker's health and of the prevention of accidents.

"Speeding Up" and Overtime Work.—The necessity of turning out rush orders or of making up for lost time results in great pressure upon employees during certain seasons of the year; this system of stimulating intense activity is spoken of as "speeding up." Not only are the employees urged on by every means to greater speed during the regular working hours but they are also compelled to work overtime. If either "speeding up" or overtime work is carried on for an extended period of time, or if they are frequently required for short periods, they usually cause a severe nervous strain. These strains, which are designated "nervous breakdowns" when experienced by people of means, often mark the beginning of physical and nervous deterioration in the employee and may even permanently impair efficiency. It is wisest, therefore, to avoid placing undue strain upon workers and to give them ample opportunity for recuperation if signs of nerve-strain appear. Moreover, care to prevent the strain due to "speeding up" diminishes the employees' liability to accidents, and thus saves him from being thrown into the industrial scrap heap and becoming dependent upon the charity of the community or of private agencies, and it is also a means of conserving to industry an efficient and experienced worker. The truth of these observations was demonstrated strikingly again and again in the recent war, when the women employees in the English munition factories were speeded up and made to work overtime and Sundays as well; the quantity and the quality of their output soon suffered as a result.

Monotonous and Fatiguing Movements.—Mention has been made several times of the effects of monotonous labor; this subject is so important as to merit more extended discussion. When an employee, day in and day out, repeats certain prescribed motions of the hands, legs or eyes that are limited in character and without variation, the monotony induces mental fatigue and overuse of the joints, muscles and nerves that may be employed, and may ultimately cause a number of peculiar diseases. Examples of these are "telegraphers' and writers' cramp" and a variety of local muscular pains, such as those occurring in the muscles of the back of the neck in typists, for instance. "Housemaid's knee" is a characteristic affection due to overuse of or pressure upon the knee-joint. The latter condition is found not only among servants but among floor-makers and floor-painters as well. Many other conditions of a similar character could be cited. While the physical effects of monotony and fatigue may manifest themselves in a variety of symptoms of local, or special functional abnormalities, the greatest importance is to be attached to fatigue as a predisposing cause of more or less grave psychic disturbances, or to general diseases such as tuberculosis due to lowered resistance. To remedy such monotony, or such excessive strain upon localized nerves, muscle groups, or joints, protec-

tive measures appropriate to the respective trades should be employed, or, employees may be given two or more varied tasks to perform during the working day. Thus, to take a rather familiar example, one who feeds a packing machine that packs biscuits into boxes, or one who feeds a printing press, if assigned, in addition, to some different kind of work for a certain number of hours each day, will find the change restful and produce a larger output in each department of work. Such variety in occupation is especially needed in very large factories where there is a tendency to make individuals who are specially adapted to certain very restricted and highly specialized tasks, machine-like in the character of their work. If diversity in work is not feasible, several rest periods should be allowed during the day.

Physical Strains.—When employees perform work which necessitates severe muscular exertion, such as lifting weights, they may acquire disease of the heart and arteries and other permanent physical disabilities, or they may aggravate abnormal conditions already existing. It is surprising to note how often men are allowed to continue an old-fashioned, laborious and clumsy method of doing things, at the sacrifice of health and efficiency, merely because it is an old trade custom. For instance, men who have to cart heavily loaded wheelbarrows or trucks that often weigh several hundred pounds, are compelled to push their loads over rough cobble-stone roads causing a loss of time, strength and efficiency, instead of being provided with handcars or other vehicles of modern construction that run on smooth floors or pavements, or on narrow-gauge rails, to say nothing of electrically propelled trucks.

In lifting heavy loads, to cite another example, the dumb-waiter, freight elevator and travelling carriage should more frequently be employed. Nevertheless, in certain factories in New York City loads weighing from three to four hundred pounds are raised to a height of two stories or more by means of rope and pulley. Or, again, when employees are required to go up and down stairs very frequently during the day, whether with or without loads, strain and fatigue are produced, especially if they are suffering from a beginning or advanced heart or kidney trouble (Fig. 100). The use of freight or passenger elevators in such cases makes for efficiency and comfort (Fig. 101).

Sales people in department stores, motormen, waiters and others, who must be on their feet either all or a greater part of the day, frequently develop swollen or varicose veins of the legs, and flat-foot. All these disabling conditions are preventable by the provision of seats for use during periods of rest, or throughout the day or during a large part of it.

Frequently, fatigue and strain of the spinal muscles are produced by chairs which have either no backs at all or have improperly constructed ones (Fig. 102). Because of the lack of support for the spine, employees assume a constrained posture and may suffer from backache and develop curvature of the spine. In work of a character which can be better performed if one leans forward somewhat, the best support for

FIG. 100.—An exhausting way of beginning or ending a hard day's work. The energy wasted in climbing several flights of stairs hastens fatigue. (Courtesy of Engineering Magazine.)

FIG. 101.—A way of saving the strength of employees. An elevator adds to the efficiency of employees, especially those on upper floors and those who carry heavy packages. (Courtesy of Engineering Magazine.)

the spine is secured by the use of a chair having a moderately low back, which is slightly tilted forward so that the upper end, preferably padded, is firmly in contact with the small of the back. If high chairs or stools are used, a foot rest will prevent dangling and congestion of the legs, and gives comfort.

FIG. 102.—For continuous work such a stool is very undesirable. The stool without a back causes bad posture and rapidly produces fatigue. (Courtesy of Engineering Magazine.)

Alcohol.[1]—There was a time when it was regarded as a good working plan to permit employees to drink beer and other alcoholic drinks while at work; it was thought to breed good cheer and contentment and to secure alacrity in the performance of work. Today every efficiency expert and wide-awake business man knows that alcoholic drinks taken over an extended period of time, even in small quantities, are particularly dangerous if used by workers whose duties require watchfulness and alertness or exposure to heat or physical strain. Dr. Moorehead of the Interborough Railroad Company of New York, reported some time ago an amazing reduction in the number of accidents among a very large group of men employed in one branch of the above transportation system, when they were forbidden to use alcoholic

[1] This section was written before the prohibition of alcohol became a law.

drinks at any time under penalty of dismissal. This group was contrasted by Dr. Moorehead with another employed in a different branch of the system, upon whom no such restriction as to alcoholic indulgence had been placed. As already stated the reduction in the number of accidents among those who abstained from alcoholic drinks was strikingly large.

However, when men and women are engaged in work in which heat and humidity are excessive they will inevitably be tempted to resort to alcohol unless water of proper temperature and palatability is freely supplied and easily accessible. If the supply of drinking water is placed at a distance from employees it will discourage the drinking of water because of the effort necessary to obtain it and because of loss of time, under such conditions thirst is accompanied by a parched throat and a feeling of weakness that makes many a worker welcome the relief and apparent stimulus he finds in liquors or other habit-forming drugs which give a sense of stimulation.

The immoderate use of alcohol is most often observed among those whose labors are extremely severe or monotonous and unvaried. There is a strong craving for something that will bring back animation to paralyzed and benumbed faculties.

When foul odors are constantly present during work, nausea or lack of appetite often results; the taste for food is destroyed and women as well as men therefore frequently seek to stimulate appetite by taking a drink of whisky or beer. This applies with special force to those working in fertilizing plants, garbage reduction works, tanneries and similar establishments. A parched throat resulting from working in an environment in which the fumes of acids, turpentine, benzine, naphtha, etc., are present, is another cause for resort to alcoholic drinks.

In America especially, observation has shown beyond any question that there is a constantly increasing tendency for the development at an early age of diseases of the heart, bloodvessels and kidneys. The death-rate from these diseases is steadily and rapidly increasing. One of the chief causes of diseases of the heart and kidneys is alcohol. If therefore, on humanitarian and economic grounds, we would conserve the lives of our workers, our efforts must be bent toward educating them to use alcoholic drinks most sparingly, if at all. The growing recognition by business men that alcohol and responsibility are incompatible will probably do more than any other influence to make for temperate use of liquors.

Warning Workers of Hazards.—As a means of accident and sickness prevention, it is perfectly obvious that those who are engaged in work that is hazardous should from the very outset be informed by word of mouth of the risks they run, and, if they can read, they should be given instructions how to guard against such hazards, by signs printed in the language they understand best. These signs should be conspicuous and placed as near to the points of danger as possible. Signs which become covered by dust or dirt are of no value; it is desirable to replace

warning signs which are familiar and to which workers have become indifferent with new ones at frequent intervals, and to change their form and wording so that they may excite renewed interest. The warning they contain should be reinforced repeatedly by verbal instruction, so as to refresh the minds of the employees and prevent their becoming indifferent.

In connection with all sanitary improvements and safeguards which are installed, which employees are likely to misuse or to ignore, the infliction of penalties by the denial of special privileges, or even by dismissal, if employees are deliberately careless and thereby imperil their own lives and those of others, may, at the outset, be absolutely essential to maintain discipline and to keep down the accident and sickness rate.

In factories in which especially hazardous trades are carried on, only the very poorest type of unskilled employee can, as a rule, be obtained. Even unskilled, newly arrived immigrants cannot be induced to stay long in certain very hazardous trades. They abandon such employment at the very first opportunity, and, especially, if the wages are low. There is, as a rule, difficulty in filling the places left vacant by such men, and employers therefore often dare not enforce discipline. When foreigners are exposed to particular hazards, competent interpreters ought to be secured to explain the dangers to which the men are exposed, as well as the methods for their prevention. In addition to this, and of even greater importance, is the installation of every reasonable device that will add to the attractiveness and safety of the employment.

It is difficult to understand why any employer who is engaged in work which is not of a temporary character, and which he hopes to continue for years, should hold back from installing modern and humanitarian methods of work. Only the business man who intends to make a one-night stand can logically object to installing the most efficient and health-conserving devices. An established business would seem logically to demand equipment and methods that will tend to promote the highest efficiency, and such efficiency is in the last analysis dependent upon the worker who is kept in the best possible form physically, and whose skill and experience are conserved for the good of the establishment by foresight and a liberal policy.

In connection with safety measures, much that has already been said in discussing the subjects of strains, dust, lighting, ventilation, etc., could profitably be repeated here. Indeed, if the topic were to be dealt with as its importance merits, it would be necessary to greatly amplify much that has previously been said. All that can be done in a brief sanitary guide of this character is to mention certain additional features of importance. Besides, since the enactment of the Compensation Laws, safety devices and methods have received so much attention at the hands of various writers that it has been sought to focus attention upon the subject of disease prevention, which, relatively speaking, has scarcely received the notice it merits.

Instructions in Safety Methods and First-aid.—Every employee should be given careful instruction so that he may thoroughly understand the machines at which he works, the care of tools, furniture and equipment, the peculiar or special hazards of his environment, and the accidents which may result from carelessness. For this purpose employees should be formed into committees under the guidance of expert instructors and supervisors, to instruct their fellow-workers in safety methods, to act as a sort of a police to warn against carelessness, and report instances of it to those in charge, if necessary, and, finally, to make recommendations as to improvements and new devices for preventing accidents.

A number of foremen and other employees should be carefully taught to administer first aid to injured employees; competence in first aid methods should be acquired by as many as possible. The instruction given in this work should lay special emphasis upon the application of methods for combating shock, whether from hemorrhage, electric currents or violent injury. The men should be taught also to employ artificial respiration, and how to prevent the soiling of open wounds pending the arrival of a physician.

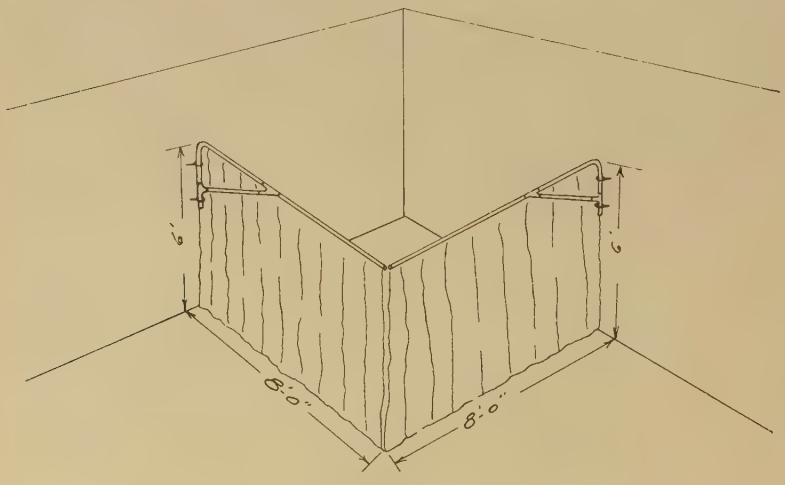

FIG. 103

A clean space or room, so situated as to be easy of access and as far as possible removed from noise and dust, should be set aside for the care of emergency cases. If such a room is not available one can be improvised as follows: A rod of thin iron piping, eight feet long, should be fastened horizontally in the wall at one end, at about six feet above the level of the floor, the free end reaching a corner of the room and the fixed end being fastened to the wall by a hinge arrangement which allows it to swing outward. Another pipe or rod should be similarly placed and fastened to the adjacent wall (Fig. 103).

From each rod is hung a white curtain, eight feet wide and reaching

to the floor. When it is desired to convert the corner space into an emergency room each curtain is swung outward at a right angle to the wall to which it is attached, thus forming an enclosure eight feet square. For economy of space a metal cot may be fastened on hinges to the wall covered by one of these curtains and turned up flat against the wall and secured in this position by a strap. When needed the cot can be unstrapped and allowed to swing downward. Surgical tables can be formed from metal or wooden plates on hinges fastened to the wall. The entire arrangement, although one that is not free from criticism, is a compact and useful one where a better arrangement is impossible.

Safety Devices.—Belting.—Belting on machinery should not be under too great tension. The ends of belting should be smoothly spliced, laced or glued; loose or torn ends should never be allowed to whirl around. Belting, if it runs within seven feet from the floor, should be guarded by sheet metal, wood, wire-mesh or railings. Mechanical belt-shifters should be installed; hand-shifting of belts should not be permitted, neither should any repairs on machinery be undertaken while it is in motion.

Guards.—Guards should be placed not only about belting but also about pulleys, gears, shafting, and all cutting, punching or sawing machines, if these are within the reach of employees working on floors or platforms. These guards should be removable for repair or inspection, but this should never be done while the machines are in motion. Also, special measures or devices should be employed to prevent the starting of machinery while it is being overhauled or examined.

Goggles and Respirators.—Strong and well-made goggles and respirators should be furnished to those whose work exposes them to flying fragments and to dust in the process of chipping, sand-blasting, grinding or polishing of stone, marble, metal or glass. Likewise, goggles should be worn by those who handle molten metal or who are exposed to blinding electric flashes. Foreign bodies which have entered the eyes of employees should be removed only by one who is trained to the work and surgically clean; all other eye injuries should be treated only by the medical attendant who is connected with the establishment or by a specialist or other physician if there is no regular medical attendant in the factory. Serious diseases and even loss of sight have frequently resulted from the attempts of fellow-workers to remove foreign bodies from the eyes of workers, or from effort to care for other forms of injuries to the eyes.

Protective Clothing.—Loose or torn clothing should not be worn by those who work near revolving or moving belting, gears or other moving parts of machinery; in order to prevent their hair from being caught in such parts girls should wear caps. Men who handle molten metal should wear substantial and well-fitting shoes without laces. (In some of the best factories asbestos covered shoes, gloves and clothing are used.) When dangerous chemicals are used, the hands and the exposed parts of the arms should be covered with gloves made of impervious material and kept in good repair.

Emery Wheels and Grindstones.—Emery wheels and grindstones should be frequently inspected in order to discover cracks and other imperfections. They should be carefully and firmly mounted, and centered without the use of wooden wedges which may expand when wet, or be driven in too vigorously, thus causing the stone to crack. Strong hoods connected with an exhaust fan should be adjusted to wheels so as to serve the double purpose of protecting the worker from accidental breaking off of a part of a stone wheel while in revolution, and also to remove dust arising in the process of grinding.

Dangerous Chemicals, Acids, Caustics, etc.—Chemical substances should be carefully stored and guarded so that fumes or dust arising from them may be properly disposed of or prevented. All open vats of chemicals should be guarded by substantial railings to prevent employees falling in. Platforms and walks situated over and around such vats should also be carefully railed in. No employee should be allowed to work alone in a room where dangerous chemicals are stored or used, because if a worker should be overcome, in the event of an accident, another should be close by to render aid. In such establishments as many as possible should receive instruction in first-aid treatment and have at hand the appropriate antidotes against the specific poisons that are employed. Labels should be attached to all containers of poisonous chemicals, and on each should appear a warning as to careful handling, and instructions as to the use of the proper antidote.

Hoisting Machinery and Elevators.—Hoisting cranes should be well guarded, and where traveling cranes are employed they should be protected with fenders, gongs and brushes to give warning of their approach. Objects to be moved on cranes should be securely placed or fastened so that they will not fall upon persons passing underneath, and workers should be warned against passing underneath moving cranes. All parts should be frequently inspected and kept in good repair.

Elevators should at all times be in charge of responsible and experienced operators, and no other persons should be allowed to run them. Efficient locks to prevent the sudden starting of cars must be provided. Doors and gates should be strongly constructed, kept in good repair, and be furnished with effective locks. Where hatches are used, the doors should be made strong and no one should be permitted to walk upon them, and strong railings should be placed about them. All cables and safety devices should be frequently inspected. Men who run elevators should, if possible, be provided with a folding seat. Constant standing causes fatigue and tends to increase the liability to accident and the development of flat-foot.

Ladders.—Too frequently ladders, sometimes of the flimsiest construction, are employed, when it would be not only practicable, but economical and safer as well, to build stairways. When ladders are necessary they should be strongly built, preferably of iron, and with hand-rails or other guards to prevent falls. When in use ladders should be firmly secured at the top and at the bottom, and the upper end

should project at least four feet above the platform or landing to which it leads (Fig. 104).

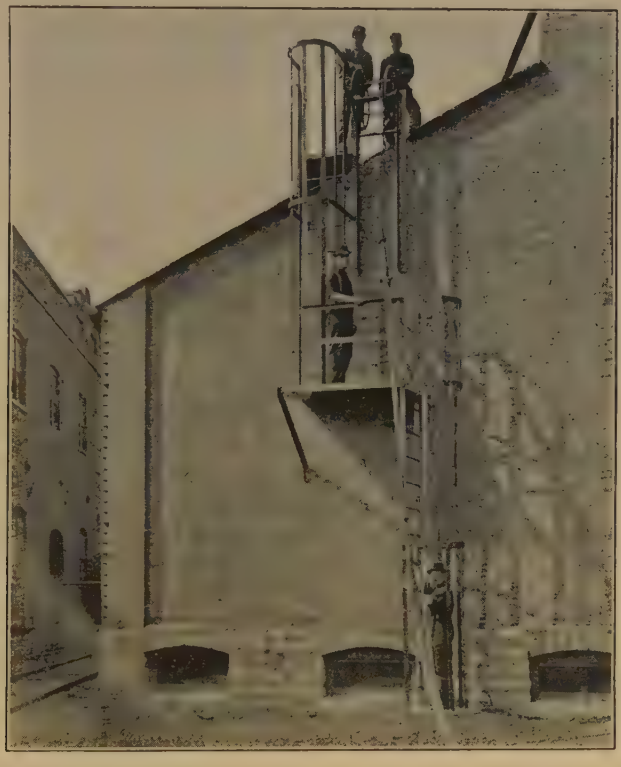

FIG. 104.—Enclosed ladder to prevent falls. (Courtesy of U. S. Steel Corporation.)

Nails.—Nails, especially rusty ones, should always be removed from floors, boards or planks from which they protrude, so that they may not cause injuries and infection to those accidentally stepping upon them.

First-aid Kits.—First-aid kits should be dust-proof and made of metal, or of metal and glass. They should be attached to the wall of a clean emergency room which is as free from noise as possible, and which gives complete privacy. Such a room should be readily accessible, and if the establishment consists of a number of floors a stretcher for carrying injured persons should be available on each floor. Additional first-aid kits and emergency rooms should be provided when a factory occupies several buildings. The quantity and character of the supplies of a first-aid kit must of necessity vary with the size of a factory and with the type of injury or accident peculiar to a particular industry. In New York State the law requires that the kit should contain the following articles:

Instruments:
1 pair of scissors.
1 thumb forceps.
1 tourniquet (to stop hemorrhage).
1 graduated medicine glass.
Medicines:
2 ounces of aromatic spirits of ammonia.
2 ounces of 4 per cent. boric acid solution.
2 ounces of alcoholic solution of iodin (tincture of iodin) for external use.
2 ounces of castor oil (for eye injuries).
2 collapsible tubes of bicarbonate of soda, 3 per cent., each tube 3 ounces, for burns).
1 pint of tincture of green soap.
Dressings:
1 dozen assorted sizes of sterile gauze bandages.
1 spool of Z. O. adhesive plaster.
3 packages of absorbent cotton, $\frac{1}{4}$ pound each.
3 packages of sterile gauze, 1 yard each.
Splints, assorted sizes.
Wooden applicators wound with cotton.
Wooden tongue depressors.
Stretcher (if factory consists of more than one floor).
2 chairs.
1 small table.
Washing facilities consisting of: water, soap, basin and towels.

Fire Hazards.—Fire hazards are being guarded against with increasing vigilance, owing to the stringency of the laws on this subject and the keen public sentiment which has been aroused by several terrible tragedies which have resulted from lack of fire-prevention methods and devices. The newspapers in particular have been alert and active in reawakening public opinion every time loss of life has occurred from this cause.

Constant watchfulness must be exercised in order to prevent smoking in factories and the careless lighting of matches where inflammable materials are handled; the example of a person in charge of an establishment smoking during working hours is pernicious. Rubbish heaps should not be allowed to accumulate, and metallic or metal-lined receptacles should be provided for excelsior, shavings, waste paper and cloth, sweepings and other materials that easily ignite. Explosive and volatile or inflammable chemicals should be carefully stored outside the main building, and they should be handled with extreme care and not brought near flames or lights. Electric wiring should be carefully insulated and frequently inspected.

Doors should open outward and should be unlocked during working hours. Fire escapes should be adequate in size and number and of substantial construction; they should have wide balconies and stairways and be free from obstructions.

Gas lights should be guarded by wire globes. Sprinkler systems, hose pipes and fire extinguishers should be freely provided. Sawdust in fire-proof containers and pails filled with water should be kept ready for emergencies.

Above all things factory buildings should be of fire-proof construction throughout, especially if they are more than four stories in height, or if large numbers are employed on the respective floors, or if the materials manufactured or handled are inflammable. Stairways should be interrupted by broad landings at each floor, and should be of a width proportioned to the number employed in the building. The stair wells should have a fire-proof enclosure. Fire-proof hand rails should be placed on one or both sides of the stairways, and if the latter are very wide an additional rail should run down the center. The treads should be of the non-slip variety and kept in good repair in order to prevent persons from falling or slipping on irregularities or holes.

Fire drills should be frequently conducted and thorough in character. The role or duty of each individual should be definitely established. Drills should be ordered at unexpected times in order to accustom employees to the atmosphere of excitement such drills ordinarily create and to prevent panics.

MEDICAL SUPERVISION.

The employment of nurses for full-time duty in a factory has become so familiar, and the value of their services has been so generally acknowledged by employers and managers under whom they have worked, that no special pleading should be required to secure a wider recognition of their usefulness in the industrial sphere. Experience in the working out of Compensation Laws has given the most convincing proof that the factory physician who is interested on behalf of the company in giving the best surgical care to those of its employees who are injured, can save his employers a great deal of money, obviate lawsuits and rapidly restore skilled workers to usefulness. In addition the physician should be competent to maintain supervision over the health of employees and suggest measures to prevent accidents and disease. Too often, unfortunately, the range of the physician's activities and his responsibilities are so narrowed that the benefits in increased efficiency and health which might otherwise be enjoyed by the worker and the employer are very much diminished. *Sometimes the fault lies with the physician, who regards his connection with the factory merely as a means of adding to his income and is therefore not sufficiently informed as to the details of factory hygiene and sanitation. More often it is due to the fact that the physician is hampered in the performance of his supervisory work, or is not consulted by foremen and superintendents in matters of which he is the best judge.*

There are as yet in this country but a handful of physicians who are competent and willing to study factory processes, the environment of the workers and the diseases and accidents to which the latter are

especially subject from the point of view of prevention. A physician who is attached to a factory in which diseases of a certain type are common is unworthy of his place if he fails to make a study of all factory conditions in order to prevent or check the occurrence of such diseases.

Accident and sickness prevention will never be thoroughly effective until companies employ a physician who will do more than establish a factory dispensary. The average general dispensary gives poor service, but the store or factory dispensary is, as a rule, the poorest of them all. The ideal factory physician is he who is competent to go through the plant and act as an adviser to the owner of a business on matters relating to sanitary engineering and to give competent advice regarding construction and equipment and their effects upon health. He should frequently inspect and reinspect the factory premises and the working conditions, so that he may be able to discover defects in sanitation and suggest corrections of wrong methods of work and faulty habits of employees. Such a physician should not be made subordinate to the foremen or supervisors, but should be made a member of the official staff, with specified duties and recognized authority. First aid and emergency service are indeed important, but they are by no means all that the physician should be required to render; his work should never be allowed to degenerate into wholesale dispensary service which gives no more than an opportunity to glance at a patient. The *x*-ray, the stomach-tube the microscope and all the other essentials for correct diagnosis and treatment must, as a rule, and of necessity, be lacking in the factory dispensary; it is therefore important in the absence of good night clinics in any community that employees who cannot afford to pay a private physician should be given leave to absent themselves from work during the day without loss of pay; this will enable them to attend a reputable day clinic or hospital for medical care. Under such a system, workers suffering from tuberculosis, cancer, diabetes, ulcer of the stomach, kidney and heart diseases, etc., will be enabled to receive early care of such nature that their lives may be lengthened and their health and comfort safeguarded. In the case of diseases which are amenable to treatment when promptly recognized, this system may also mean the restoration to health and activity of many who might otherwise become hopelessly ill or disabled.

The preliminary medical examination of all applicants for work frequently brings to light signs of a beginning or advanced disease of the heart, lungs, kidneys, eyes, ears or of other organs, which may predispose the applicant to the occurrence of accidents or cause premature death. Periodic medical examination of all employees exposed to occupational hazards is undoubtedly of the greatest preventive value.

There are many small industrial establishments the owners of which recognize the value of the industrial physician and nurse, but find the cost of their services too great to bear unaided. There is no reason why a number of such small establishments situated in one building, or

in a restricted locality or zone, or having common trade interests, should not unite to secure medical assistance through a central medical service station, by dividing the cost.

Finally, the physician and nurse should be required to keep careful records of all cases of sickness or accident arising during the course of the year, whether these are cared for by the industrial nurse or physician or by private agencies. Such a record would be of value not only in showing the extent and worth of the physician's or nurse's work but would also indicate the departments or processes which are particularly dangerous and thus suggest the need for special remedies. Thus, if a large number of "colds" were traced to a special department, or if pneumonia, tuberculosis, rheumatism, skin diseases or "flat-foot" were found to be prevalent among a particular group of employees, a search for the special cause of the undue frequency of any of these conditions would naturally suggest itself. The nurse, in addition to her special ministrations to sick or injured employees, should also acquaint herself with home conditions and domestic habits that may be undermining the health of workers, and when these are ascertained, she may, by persuasion and friendly visits of instruction, seek to assist in eliminating certain causes of physical impairment or disability by giving advice as to diet, ventilation, the proper use of sleeping quarters, etc.

CHAPTER XXV.

CHILD HYGIENE.

By S. JOSEPHINE BAKER, M.D., D.P.H.

Child hygiene is a broad term which is used to designate all matters which pertain to the physical well-being of children before the period of adolescence. This age group has been used as a unit in public health activities because of the recognition of several factors: (1) According to the census of 1910 one out of every five deaths at all ages occurs under the age of one year and one out of every three deaths at all ages occurs under the age of five years. (2) Ninety-five per cent. of the cases of contagious diseases occur under the age of fifteen years, while 90 per cent. occur under the age of five years. (3) Preventive health work for the individual is most effective when it deals with an age group which is in process of growth. Health habits, as well as health itself, can be established in the period of childhood more certainly than after growth has taken place.

In order to be fully effective, child hygiene work must be inclusive of all activities and environmental conditions that in any way affect child life from the prenatal period to puberty. For this reason the State and municipal health authorities have established bureaus or divisions of child hygiene. New York City established the first bureau of this kind in 1908. Since then, thirty State divisions have been established.

Federal recognition of the importance of this work was accorded on April 9, 1912, by the establishment of the Federal Children's Bureau under the United States Department of Labor. Practically every city of importance in the United States has a division or bureau of child hygiene and they are almost equally common to small communities.

Organization.—The organization of a bureau of child hygiene must depend largely upon the appropriation available and whether the work is to be done in an urban or a rural community. It must be recognized that preventive health work for children has grown to be a definite specialty and people assigned to such duty should not, unless the exigencies of the rural service demand such action, be assigned to any duty other than that pertaining to the care of infants and young children. The effective results that have been attained in certain American cities have occurred where this program of specialization has been carried out. In other cities where physicians and nurses were assigned to various duties including child hygiene, the results have been distinctly less satisfactory.

There should be a physician in charge of this bureau. While administrative ability is of first importance and may be considered

absolutely essential, the background afforded by a medical education preferably followed by education in public health, is necessary for a person who must outline the policy, prepare the program and be responsible for results in child hygiene work. Under this director or chief, who should be a full-time employee, may logically be placed various chiefs of divisions and a superintendent of nurses. In small towns such added officials will be unnecessary; in cities, owing to the rapid growth of this work and the extension of its activities, this further specialization seems essential. Supervising inspectors and supervising nurses, responsible to the chiefs of divisions and the superintendent of nurses, should have immediate control of the field force. The essential clerical force is, of course, implied. In small towns or rural communities, the organization must be adapted to the circumstances.

Functions.—The functions of a well-organized bureau of child hygiene should include:

1. Regulation and standardization of obstetrical procedure by:

(*a*) Education, licensing and control of midwives.

(*b*) Supervision of standards of lying-in hospitals.

(*c*) Provision for maternity nursing.

2. Prenatal work, including:

(*a*) Establishment of prenatal or maternity centers.

(*b*) Supervision and instruction of expectant mothers.

(*c*) Essential legislation for protection of women of child-bearing age or pregnant women in industry.

3. Reduction of infant mortality by:

(*a*) Measures outlined under (1) and (2).

(*b*) Instruction of all mothers of children under one year of age with necessary health supervision of such infants.

(*c*) Readjustments of social, economic and environmental conditions.

(*d*) Education of young girls in personal hygiene and in the care of infants.

4. Health supervision of children of pre-school age by:

(*a*) Maintenance and supervision of day nurseries.

(*b*) Supervision and control of institutions caring for dependent and delinquent children.

(*c*) Health examinations and follow-up of children of pre-school age.

5. School medical inspection by:

(*a*) Health supervision of all children of school age.

(*b*) Establishment and maintenance of standards for school hygiene.

(*c*) Establishment or supervision of adequate facilities for the treatment of defects or illnesses of children.

6. Child labor.

(*a*) Establishment of legal standards controlling the employment of children.

(*b*) Supervision of children under sixteen years of age engaged in industry.

(*c*) Establishment of health standards essential for the issuance of employment certificates.

CONTROL AND SUPERVISION OF MIDWIVES.

The relation of the employment of midwives to the mortality or morbidity of childhood varies in different parts of the country, dependent upon the extent of the employment of these women. In certain western States midwives take care of as high as 75 per cent. of confinements. This practice is particularly common in some rural communities where either professional midwives or women neighbors attend a large proportion of the births. Studies as to the extent of this practice and the lack of care at time of confinement have been made by the Federal Children's Bureau. In the east, legislation regarding the practice of midwifery shows great variations. In certain States, the practice of midwifery by other than regularly qualified physicians is prohibited, yet a number of midwives continue to take care of women at confinement and even report the births. The attitude of health authorities toward midwives varies. Some States completely ignore them, some have legislated against their right to practice, some have established standards of practice, while others have required some preliminary education. New York City requires a six months' education at a school for midwives under municipal control.

The practice of midwifery in Europe is well regulated. England requires a six months' preliminary training while all other countries require courses of training varying from one to two years. After graduation, these midwives are all under government control and subject to stringent regulations. The possibilities of harm resulting to the mother or child owing to lack of care at time of confinement are so obvious that no other argument would seem necessary for the supervision of midwives.

In such supervision the following points should be insisted upon:

1. Registration and licensing of all women found competent to practice midwifery. This licensing should be based upon:

(*a*) Adequate preliminary education and training of at least six months in a properly supervised midwifery school.

(*b*) Moral character and good personal habits.

(*c*) Strict adherence to the regulations covering the practice of midwifery.

2. Supervision of midwives. After the midwives have been licensed they should be:

(*a*) Under active supervision by physicians or visiting nurses.

(*b*) Regularly instructed individually and in classes as to proper methods of procedure.

Ophthalmia Neonatorum.—Physicians and midwives should be required to report every case of sore eyes occurring in their practice in a baby under ten days of age. Each such case should be visited by a physician and, if discharge is present, a smear should be taken to determine the presence of the gonococcus. Such children should be referred immediately for treatment to a physician or hospital and

the case should be kept under observation by the visiting nurse to see that such treatment is received.

In case of positive diagnosis of gonorrheal ophthalmia, close supervision should be maintained over each case and in no instance should the case be discharged from supervision until it has been terminated so that the final results may be known. Use of the silver nitrate solution in the eyes of newborn babies should be required of midwives and urged upon physicians. It has been found in public health practice that the required use of this prophylactic will decrease the number of cases of ophthalmia neonatorum to a minimum and that the early recognition of these cases, with subsequent adequate treatment, has practically eliminated blindness as a result of this disease.

Puerperal Septicemia.—Deaths of women due to accidents or diseases of childbirth have been steadily on the increase in the United States. It is estimated by the Federal Children's Bureau that in the age group from twenty to forty-five years of age diseases and accidents of childbirth furnish more deaths of women than any other tabulated cause of death except tuberculosis. In a recent bulletin issued by the Children's Bureau of the United States Department of Labor, in a discussion of maternal mortality, Dr. Grace L. Meigs states as follows: "Mortality figures do not show a decrease in the death-rates from childbirth in the larger cities in recent years. The death-rates of the whole group of cities of eight thousand or more inhabitants in the registration States for the years 1900 and 1913 show no decline. The rate in 1900 was 14.9 and in 1913 17.2. The death-rates from childbirth for the same period in a group of seven large cities have been studied; the rates from New York City alone show a definite and steady decline. In 1905 the rate per 100,000 inhabitants was 20.3, in 1913 14.1."

The reporting by physicians and midwives of every case of puerperal sepsis should be insisted upon and in each instance investigation should be made to determine whether or not the disease was the result of criminal interference or carelessness. The revocation of licenses and the prosecution of midwives, as well as prosecution of physicians, for negligence in this direction, has a deterrent effect and is a justifiable procedure for the reduction in the number of cases of this disease.

INFANT MORTALITY.

As prenatal work is distinctly a part of the campaign to reduce infant mortality, it will be considered under this section. Infant mortality is the number of deaths of infants under one year of age per thousand living births occurring in the same area in any one calendar year (Eastman). This standard has been decided upon as providing the most accurate information obtainable in various localities. Strictly speaking, infant mortality should be based not upon the number of living births in any one calendar year but upon the exact ratio of the number of children born and who live to pass their first birthday, irrespective of the year in which they were born. Such

statistics, however, are readily obtainable only in institutions where babies are born and are kept during their first year. In cities or even in smaller communities, such data would be difficult to obtain. For purposes of accurate statistical data, however, it may be obtained, for part of a community, as for instance in studies made by the children's bureau where the births for a certain year are tabulated and each case is followed up. In cities, owing to the migratory habits of so large a proportion of the population, this method has been found to be practically impossible. A survey undertaken in New York City of two thousand births for the purpose of following them up for a period of five years had to be abandoned because at the end of the first year over 30 per cent. of the families had moved without leaving any address and at the end of the second year over 50 per cent. of the remainder could not be found. Adult mortality is usually based upon the estimated population. The method, therefore, of recording infant mortality as given above has the advantages of (*a*) practical accuracy, (*b*) standardization so that it is comparable with the infant death-rates of other communities.

The Problem of Infant Mortality.—Waste of life at its beginning is essentially a public health problem. As will be seen later, the causes of infant mortality are so complex and in general so closely related to community life and environment that the individual, unaided, has little opportunity to combat it. While the efforts to control infant mortality are mainly directed to the education of the mother, it is important that the community provide for the necessary social, economic and hygienic aids for the mother to use. For the past fifty years the general death-rate has shown a marked and steady decrease in all civilized countries. The infant mortality-rate has also shown a decrease but not as marked as that of the general rate. Owing to the meager statistical data available in the United States reference will have to be made to Europe in this regard. Table I, showing the birth-rate per thousand of the population, the death-rate per thousand of the population and the infant mortality per thousand of the population in England and Wales for ten-year periods from 1851 to 1905 illustrates this tendency. It also shows the striking reduction of the birth-rate, a reduction which is common to the countries of Europe but which has not yet shown itself in the United States.

TABLE I.—ENGLAND AND WALES.

	Birth-rate per 1000 population.	Death-rate per 1000 population.	Infant death-rate per 1000 population.
1851 to 1860	34.1	22.2	154[1]
1861 to 1870	35.2	22.5	154
1871 to 1880	35.4	21.4	149
1881 to 1890	32.5	19.1	142
1891 to 1900	29.9	18.2	154
1901 to 1905	28.4	16.0	138

[1] From 1832 to 1850 the average infant mortality in England and Wales was 153.

The reduction that has already taken place in infant mortality is due very largely to improved environmental conditions. The infant is acutely sensitive to its environment. It has become a trite but none the less true statement that infant mortality is the most sensitive index we have of the sanitary condition of any community. The fact, therefore, of general improvement in health conditions and in sanitation has been reflected in a general reduction in the infant mortality-rate. This reduction, however, has not kept pace with the reduction in the general death-rate and it has become apparent that if this waste of life is to be stopped, the reduction in the death-rate of infancy must be considered by itself and have individual and intensive methods applied to it.

There is no part of life where the death-rate is so high as under one year but, correspondingly, there is no part of life where reduction of the death-rate offers fewer difficulties. The distribution of the infant death-rate by months has a marked bearing upon the methods taken to reduce it and the degree in which it may be considered preventable. In the registration area of the United States in 1910, 154,373 deaths occurred under one year of age, with a death-rate of 15.95 under one year based upon one thousand estimated infant population under one year. The ages at which these children died are shown in Table II.

TABLE II.

	No.	Per cent.
Died during first day of life	14,946	0.10
Died during first week of life	36,351	0.24
Died during first month of life	58,089	0.38
Died during first three months of life	86,235	0.56
Died during first six months of life	116,039	0.75

This table is of interest as a comparison with one made by Farr of England in 1864 in his report as Registrar-General:

TABLE III—DEATH-RATE BY MONTHS OF INFANTS IN ENGLAND AND WALES 1851 TO 1860.

Age in months.	Boys.	Girls.	Total.
0 to 1	64.50	49.45	57.13
1	24.09	19.50	21.83
2	17.18	14.19	15.71
3	14.42	11.91	13.18
4	13.86	11.30	12.60
5	13.29	10.76	12.05
6	12.71	10.27	11.50
7	12.11	9.84	10.99
8	11.50	9.48	10.50
9	10.86	9.18	10.03
10	10.22	8.93	9.58
11	9.56	8.75	9.16

While this waste of life in infancy is deplorable at any time, it becomes a menace to the future integrity of the country if long continued and particularly if taken in connection with the falling birth-rate. This is particularly true in time of war where the mortality in

the adult group is apt to be excessive and where the future welfare of the country must depend entirely upon the virility of the next generation. During the past World War it was estimated by the Registrar-General of England—Sir Bernard Mallett—that the reduction in the birth-rate during the first three years of the war among European belligerents amounted to a loss of over 650,000 potential lives in England, over two million potential lives in Germany and 1,600,000 in Austria-Hungary. He stated that the total reduction in the birth-rate in all European countries at war had, in the first three years of the war amounted to a potential loss of life in excess of 12,500,000 and that the war is causing a reduction in the birth-rate equivalent to the loss of seven thousand lives per day..

Causes of Infant Mortality.—The causes of infant mortality are complex and inclusive of all factors which in any way concern the health of an individual. These factors bear most heavily upon infancy because the infant is more acutely sensitive to his surroundings than any other age period. This sensitiveness decreases in proportion to the age of the child and after adult life is reached it remains stationary and limited in degree. The causative factors tend to blend into each other or to overlap. A sharp separation is difficult but, in general, they may be considered under two headings: (1) Environmental, including all matters pertaining to the general hygiene and sanitation of the community and to economic and social factors and (2) medical, including the actual contracting of disease.

Sanitary, Hygienic, Social and Economic Causes of Infant Mortality.—Fundamentally, infant mortality may be said to be caused by two factors—poverty and ignorance. Further analysis, however, should be made. The environmental conditions may be classified as (*a*) social, (*b*) economic, (*c*) racial and (*d*) general environment.

It is difficult to show the exact statistical relation between the general sanitation of a community and the infant death-rate but that this relation exists may be proved by a consideration of the fall in the infant death-rate concomitant with that in the general death-rate, due to improved sanitary conditions. Clean streets, improved housing facilities, opportunities for fresh air and a supply of pure water, are all general conditions which have their effect upon the reduction of the infant mortality even more surely than they have upon the adult mortality.

Overcrowding.—Certain more intimate unhygienic conditions, however, bear directly upon the infant morbidity and mortality-rates. Density of population in any given acreage does not in itself bear a direct relation to the infant death-rate. The number of people in a given area may cause conditions of overcrowding, if the buildings are limited in height, whereas there may be no such overcrowding in buildings covering the same acreage but which comprise many more floors. The true effect of overcrowding upon infant mortality relates to the density of population in rooms rather than ground space. Taking it from this point of view, it has been shown definitely in studies

made by Newman, of England, that in a group of families studied the death-rate was as follows:

	Infant death-rate.
Those living in one room	219
Those living in two rooms	157
Those living in three rooms	141
Those living in four or more rooms	99

It was also found that the infant death-rate was twice as great with five people living in a room as with two living in a room. The infant mortality-rate in connection with the number of people living in a room is affected by the related factors which include lack of proper ventilation and neglect of personal hygiene. Such conditions have a marked influence upon the occurrence of contagious diseases, particularly measles and the respiratory diseases in young infants.

Unhygienic Conditions.—The actual relation of cleanliness or filth in living apartments is shown graphically by the report of conditions in Johnstown, Pa., where the infant death-rate was found to be as follows:

Clean rooms	113.5
Dirty rooms	186.

The type of home lived in also had its effect, irrespective of cleanliness. This is shown clearly by the amount expended for rent. The index that was adopted in this case was whether or not water was piped into the house and whether or not there was a bathtub in the house. It must be understood that the relation of the water or the bathtub can in this instance be considered nothing more than an index to the social status of the family and their presumptive poverty and manner of living. The infant death-rate under such conditions was found to be as follows:

Water piped into house	117.6
Water carried into house from outside	197.9
Bathtub in house	72.6
No bathtub in house	164.8

Immigration.—The influence of the influx of alien races upon infant mortality must include a consideration of delay in adapting methods of living to the new environment, as well as ignorance and poverty. The city statistics of New York City made by Guilfoy show that out of every thousand infants born to mothers of Russian-Polish or Austro-Hungarian nationality, over 920 survive the first year of life. Of infants born to Italian mothers, 897, of native mothers, 894, German mothers 885 and Irish mothers 881 survive this trying period of existence. Other significant results of this analysis show that of all deaths from congenital diseases under one year of age per ten thousand births reported, the nationality of the mother seems to be a dominating factor. The death-rate from these causes in children born of Italian mothers was 295, Russian-Polish 320, Austro-Hungarian 284, native 544. This striking analysis has a marked relation to the causative factors involved in the deaths from congenital diseases and clearly

indicates that the method of approach in the future must take into consideration more than it has in the past the high death-rate of children of native parentage.

The effect of nationality upon deaths from infectious diseases shows that children of Italian mothers show the highest mortality from this group of diseases, with a rate of 58. The children of Irish mothers rank next, with a rate of 57, children of native mothers 38, children of Austro-Hungarian mothers 36.

In acute respiratory diseases race seems to play a very marked part. The death-rate of babies of Italian mothers from respiratory diseases is "more than three and a half times that of children of German mothers, almost three times that of children of Russian, Austro-Hungarian and Irish mothers and a little more than double that of American mothers."

In the mortality from diarrheal diseases, the racial aspect is shown as follows: Children of English parents 91 per ten thousand, children of native parents 80 per ten thousand, children of Irish mothers 72 per ten thousand, children of Italian mothers 70 per ten thousand, children of Austro-Hungarian mothers 52 per ten thousand and children of Russian mothers 30 per ten thousand. The influence of race upon infant mortality may therefore be summed up as follows: The highest death-rate from congenital causes is among children of native parents, the highest death-rate from infectious diseases is among children of Italian mothers, the highest death-rate from acute respiratory diseases is among children of Italian mothers, while the highest death-rate from diarrheal diseases is among children of English and native parents. It is impossible to quote figures taken ten or twenty years ago in regard to this matter but experience of health workers in large cities would seem to point to a marked change from the conditions enumerated.

In the early years of child welfare work it was apparent that the highest infant mortality occurred in practically all classes of disease among children of foreign parentage. That in at least two instances—congenital diseases and diarrheal diseases—the highest mortality-rate is in children of native parentage offers a subject for consideration in planning programs for child welfare at the present time.

Economic.—Poverty, and therefore wages, in relation to infant mortality, is fundamental. If a living wage and universal education in health matters prevailed it is possible that the infant mortality-rate could be reduced to an, at present, inconceivable minimum. Students of sociology have a well-grounded basis for their belief that poverty is the basis of practically all morbidity occurring in that group of people whose wages are below the limit which provides decent living conditions. The Johnstown report gives definite relation between the wages of the father and the infant mortality. It was shown in that investitation that where the father earned less than $521 per year the infant death-rate was 255.7 and where the father earned more than $1200 per year the infant death-rate was 84. The rate of wages, how-

ever, must be considered in relation to other related circumstances. For example a low rate of wages for the man of the family results almost invariably in forcing the mother into industry. The question of the effect of industry upon the health of potential or expect mothers is one that has not yet been sufficiently studied. It has been found, however, that in the industrial sections of England where 41 per cent. of the mothers are employed, the infant mortality-rate is 150 and in those industrial cities and towns where 88 per cent. of the mothers are employed, the infant mortality-rate is 182. The result of industry upon the health of the expectant mother or the potential mother has not been reduced to statistical form. Much depends upon the character of the occupation, including the amount of fatigue, physical strain, insanitary environment, length of hours of work, hazards which may result in accidents, the presence of poisonous fumes or irritating dust. By-products of women in industry which are sometimes shown in either ignorance of child care or neglect of the child while the mother is working, all have a direct bearing upon the infant mortality-rate.

This early neglect of children is reflected in the figures quoted in England by Newman which show that when a mother returns to work in less than a month after confinement, the infant death-rate was 136.7, and that when the mother returned to work one month or more after confinement, the infant death-rate was 112.5. Attention has been called to the effects of subnormal living conditions upon the pregnant women by a realization of the large proportion of deaths under one year of age which occur in the first month of life, amounting to 38 per cent. of the total. As practically all these deaths are due to so-called "congenital diseases" and are the result of the physical condition of the mother before the baby is born, it may readily be seen that all social, economic and environmental factors which tend toward lowered hygienic conditions during the period of pregnancy have a marked effect upon the infant mortality-rate in the early months of life. The soundness of this reasoning has been proved by the results which have been achieved as a result of so-called "prenatal work" where the infant mortality in the first month of life has been reduced one-half as a result of proper supervision of the expectant mothers. This matter will be considered later under "measures for reducing infant mortality."

Illegitimacy.—The death-rate among illegitimate children is abnormally high. Generally, in the United States, the fact of illegitimacy is not recorded. It is therefore difficult to obtain exact statistics except from European countries. In England, however, it has been found that deaths among children born out of wedlock are from two to two and a half times as great as the number among children born of wedded parents. The cause of this excessive death-rate is found in the natural weakness of the children as a result of the great mental strain on the part of the mother, with resultant physical weakness and lack of vitality, and also the neglect of the child during the early period of infancy which is so common under such circumstances.

TABLE IV.—DISTRIBUTION OF INFANT MORTALITY IN THE UNITED STATES (CENSUS OF 1910) BY CAUSES.

	No.	Per cent.
Congenital diseases	46,852	0.30
Diarrheal diseases	45,440	0.29
Respiratory diseases	23,187	0.14
Contagious diseases	6,092	0.04
Other causes	32,792	0.21

Congenital Diseases.—The causes of this—the highest group of deaths under one year of age—have been partially discussed before. In detail, however, we must consider:

1. *Prematurity.*—This is due usually to syphilis or to social or economic factors which are affecting the health of the expectant mother. As a cause of infant deaths, syphilis does not rank high, giving from 1.2 to 2 deaths per thousand births. The reason for this is that practically all syphilitic conceptions result in stillbirths. If the syphilis has occurred in the mother, the stillbirths may range from 60 per cent. to 100 per cent. of all conceptions; if the infection is directly from the father, the mortality is much lower—from 28 per cent. to 35 per cent. The other causes of prematurity are those of extremely lowered vitality of the mother due to underfeeding or overwork or to actual undue physical strain or accident.

2. *Feeble Vitality.*—Feeble vitality furnishes by far the greatest number of deaths from congenital diseases. The causative factors in the mother are all that relate to poor social and economic conditions, including overwork and strain, industrial diseases, lack of food, or of fresh air and general unhygienic living conditions. Feeble vitality as a cause of death in the infant is simply an expression of the lack of physical power to live, dependent upon the lowered physical vitality of the mother.

3. *Accidents of Labor.*—This group is so small that it cannot be considered as a public health problem.

4. *Alcoholism.*—Alcoholism as a cause of deaths from congenital diseases does not rank high. There can be no question that if alcohol circulates in the blood of the pregnant woman it will reach the fetus and injure the tissue for the proper development of the cells. Such cases, however, are difficult of actual tabulation. The main result of the effect of alcoholic parents upon the deaths of children is found under the age of two years, where we may consider the results due to environment and resultant neglect rather than to heredity. Studies of groups of such children under two years of age have shown that the death-rate of children of drunken mothers was 55.2 as compared with a death-rate of 23.9 among children of sober mothers in similar environment.

Diarrheal Diseases.—From a public health point of view, the cause of diarrheal deaths must be considered as dietetic. The specific bacteriological cause of such diseases is of marked interest and should be considered, but from the point of view of handling the problem the

question of feeding assumes paramount importance. Heat in its relation to the reduction of infant mortality has been considered an important factor. Results shown, however, in cities where adequate infant welfare work has been carried on, have demonstrated without question that the infant mortality-rate may be kept as low in summer as it is in winter. The effect of heat upon infant mortality is shown mainly in two directions: (1) In lowering the general vitality of the infant. The heat centers of the young child are much more unstable

DEATH RATE FROM ALL CAUSES IN CHILDREN UNDER ONE YEAR OF AGE PER 1000 BIRTHS
NEW YORK CITY
COMPARISON OF YEARS 1907 AND 1913
JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
1907
1913
WEEKS

FIG. 105

than are those of the adult. The infant, therefore, is apt to feel the effects of severe heat much more than the adult. (2) The effect of heat upon milk is a matter which need not be discussed here. Undoubtedly, the vast epidemics of diarrhea in the past have been due largely to this factor. With the improvement in the condition of the milk supply, the almost universal pasteurization of milk and the extended public health education of mothers in the care of milk in the homes, this problem has been practically solved.

A chart showing the status of the infant death-rate in New York City in 1907 and 1913 is shown herewith. 1907 is taken as representing the increased baby death-rate during the months of July and August which obtained up to that year and for two or three years afterward. About 1910 this summer rise began to decrease in a marked manner and the line for 1913 shows about the average status of the summer increase since that time. For the past five years the general infant mortality curve has been little, if any, higher during these two summer months than during the spring months. The actual heat, therefore, would seem to bear a less distinct relation to the production of diarrheal diseases than has been thought to be the case and it may be stated that its effects may be completely nullified by proper supervision of mothers and babies.

Respiratory Diseases.—Little is known of the causative factors of the death-rate from respiratory diseases except when they occur as terminal conditions of one of the infectious diseases, particularly measles or whooping-cough. In such instances the causative factor relates to the original disease, and methods for dealing with these cases must be considered from that point of view. In common with the occurrence of respiratory diseases among adults, we find striking confirmation of the belief that they are closely allied to lack of ventilation and bad air.

Contagious Diseases.—These furnish only 4 per cent. of the total deaths under one year of age and are of interest more because of their sequelæ or complications than because of their place as a cause of deaths in infants. Two diseases that are of particular importance at this time are measles and whooping-cough, both of which are diseases of severity when occurring in children under one year of age.

REDUCTION OF INFANT MORTALITY.

Complete and adequate birth registration is the foundation of all effective programs for baby saving. For methods of obtaining such registration, reference should be made to standard text-books on vital statistics. Programs for the reduction of infant mortality must have as their first point of attack the reduction of infant morbidity. It may be stated that any efforts which result merely in reducing the number of deaths under one year of age cannot be considered as satisfactory. The problem of child welfare is not one of an individual age group. The true test of the efficacy of public health work for the reduction of the infant death-rate must be found not in the infant death-rate itself but rather in the death-rate of the succeeding years of child life. The reduction of the morbidity and mortality-rates under five years of age, therefore, are the final measures of the efficiency of the work directed at the reduction of the death-rate under one year.

Community Program.—The early steps to combat the excessive infant morbidity- and mortality-rates must be those pertaining to community

sanitation, general hygiene, improved housing, prevention of overcrowding, provision of a pure water and pure milk supply and proper facilities for recreation and fresh air and the control of infection.

Unless a community is particularly progressive, it is probable that a large amount of public education will have to be carried on before even a modest program can be put into effect. The first step, therefore, should be to arouse community interest. This is often best done at first through the medium of local clubs, churches or welfare organizations. The ultimate responsibility, however, should rest upon the health department and as soon as possible the work should be placed under their direct control. In order to determine the extent of infant mortality in a community, it is necessary to have accurate vital statistics. If these are not available, a survey of the community should be made, including a study of the births and deaths. These should be graphically portrayed by means of pin maps so that the number and places of the births and the number, places and causes of the infant deaths may be readily apparent. A public exhibition should be made of such map, at local meetings, where doctors and nurses may call attention to the infant death-rate of the community and the reasons why such work is essential. As publicity is such an important factor in a campaign of this type, the close coöperation of the public press is essential.

Local boards of health must be held responsible for the general sanitation of the community and the laws relating to proper housing facilities, and these should be rigidly enforced. The provision of a proper milk supply is of the utmost importance and unless it can be determined beyond the question of a doubt that the milk supply of a community is perfectly safe, laws requiring pasteurization should be passed and enforced. While the instruction of the mother in the care of the child should rest entirely upon methods concerned with public health education, it may be necessary to have certain legislation affecting the community as a whole. Such legislation should include (*a*) provision for maternal insurance or payment of a subsidy to pregnant women at the time of and for at least four weeks after confinement, (*b*) laws preventing women working for at least one month before and one month after confinement, and (*c*) laws regulating hours and conditions of women working outside the home.

Individual Program.—Public health work in baby care should consist of one or more of the following factors:

(*a*) Prenatal work.

(*b*) Baby health centers or infants' milk stations.

(*c*) Home visiting by nurses.

(*d*) Mothers' conferences.

(*e*) Little Mothers' Leagues.

(*f*) Public health education, including lectures, educational literature, pamphlets and newspaper articles.

(*g*) Auxiliary aids and coöperation of all infant welfare organizations.

Prenatal Work.—In the registration area of the United States in 1910, 30 per cent. of all deaths under one year of age occurred from congenital diseases, thus being the cause of the greatest proportion of infant deaths. Efforts to reduce this death-rate, which occurs almost entirely during the first month of life, are based upon proper supervision of the health of the mother before the child is born. In order that this supervision may be effective, the mother should be reached as early in pregnancy as possible. While a great deal of proper preventive work may be done after the third month of pregnancy, it becomes increasingly difficult from that time on and after the sixth month it is probably little more than supervisory.

Knowledge of these expectant mothers may be obtained through information furnished by social workers, welfare centers, visiting nurses or by the voluntary registration of the women themselves at some local center. Prenatal nurses, on their first interview with the expectant mother, should determine whether or not a physician or midwife has been engaged for the confinement. If not, the nurse should get into immediate communication with a hospital or physician and see that the expectant mother is at once examined. Throughout the period of supervision the nurse should remain in touch with the doctor in charge of the case and should report to him at once any evidence of abnormal symptoms occurring in the expectant mother. Visits should be made by the nurse every three weeks up to the fifth month of pregnancy and then every ten days until delivery. In abnormal cases visits should be made as often as indicated. After birth of the child the case should be visited every day for a week and then every five days until the end of a month. At the end of that time the baby should be referred to a baby health station for continued supervision.

The type of instruction to be given by the nurse to the expectant mother should include full directions regarding sanitation of the home including its cleanliness and proper ventilation. The patient must be carefully instructed regarding proper diet, clothing, exercise, rest, bathing, care of the teeth and of the breasts and whatever instructions may be necessary in individual cases. The urine should be examined at least once a month and if any abnormality is discovered, such fact should be reported to the physician at once. The patient should be instructed that if any of the following symptoms occur a physician should be sent for at once and the nurse notified: Severe and persistent vomiting, constant headache, swelling of the legs or ankles, scanty urine, muscular twitching, convulsions or bleeding. Any symptom which would seem to be suggestive of tuberculosis or syphilis should lead to immediate medical care and in each case of suspected syphilis a Wassermann test should be made.

Maternity Centers.—In order to make prenatal care more universal and to educate the public as to its necessity as well as to provide proper supervision of the expectant mothers, maternity centers may be organized. These centers should be in the nature of educational

centers. At certain hours of the week a doctor should be present to examine the expectant mothers and make a complete clinical record of their condition. A registrar should be provided also, to be in charge of the clinic and of the records. All child welfare agencies in the vicinity should coöperate with the maternity center by referring thereto all expectant mothers who apply to them for care, and such others as they may be able to enroll. Such maternity centers do not supplement the work of other organizations nor should they necessarily be entities. They serve rather as clearing houses in order to prevent duplication of effort and all prospective mothers enrolled and examined at these centers are thereafter cared for by the agency who is working in the district in which the prospective mother lives. While it is not advised that the public health nurse should care for the mother during her confinement, it is desirable that some nursing care should be arranged for. Probably the best arrangement would be adequate facilities in lying-in hospitals, with competent medical and nursing care. When this cannot be obtained, however, it may be seen that the careful supervision of the midwife, who carries on both medical and nursing functions, is of the utmost importance. As the greater part of the reduction of infant mortality in this country has taken place in the class of cases known as diarrheal diseases, with a lesser reduction in the respiratory disease and contagious disease groups, it is evident that in the future more strenuous efforts must be put forth in the line of reduction of the infant death-rate from congenital causes.

The methods outlined have been shown to be effective. In practically every town where they have been tried, including Boston and New York, the infant death-rate of the babies of mothers who have been under supervision during their term of pregnancy has amounted to a little more than half that of the general city rate for the same period. Not only has the infant death-rate been thus decreased 50 per cent. during the first month of life, but the effects are equally good in the opportunity which is given of reaching the baby at the beginning of its life, when education of the mother as to the necessity of breast feeding can be carried on with the least amount of resistance, and in the cases under supervision in New York City it was shown that 94 per cent. of the children were entirely breast fed at the end of one month. The educational possibilities of this line of work, therefore, are of the highest importance. Moreover, by keeping the child under continuous supervision from birth throughout the first and second years, almost perfect health control is assured. Such work meets the test already outlined of effective public health work for infants by not only saving life but assuring the almost total absence of morbidity during the first and succeeding years.

Baby Health Stations.—The term "baby health stations" is used to designate the various infants' milk stations, infant welfare centers and other organizations of similar type. In the past their function was largely concerned with the provision of a proper type of milk for infant

feeding and the necessary instruction to see that such milk was properly prepared. In later years their educational functions have been much extended until now their main object is the extension of breast feeding to all infants and the necessary instruction of the mothers by trained nurses in all methods of proper baby care. The infants' milk stations or baby health stations are a direct outgrowth of the "consultations de nourissons" which were established in 1890 by Professor Budin at the Charité Hospital in Paris and the "goutte de lait" which was established in Paris in 1892 at the Belleville by Professor Leon du Four. The consultation de nourisson was associated with the lying-in hospital and was simply an attempt to continue supervision of the babies born there. They were required to be brought back once a week for weighing. Breast feeding was encouraged but if this was impossible, sterilized milk was given out by the clinic. Our present milk stations are more in the nature of the goutte de lait. Here milk was distributed for infant feeding and a beginning was made in pasteurizing and modifying the milk for that purpose.

The first infants' milk station in the United States was started by Nathan Straus in New York City in 1898. This followed closely the type of the goutte de lait. Milk already modified according to certain prescribed formulæ for different ages was placed in individual feeding bottles and when a baby was registered at the station the mother could procure each day the proper amount of food for her child on payment of the cost price. No physicians or nurses were in attendance. The value of these stations was very great at the time they were started because the community milk supply at that time was not carefully supervised and the milk sold at the Straus stations, which was all pasteurized, was the best milk which could then be obtained. Since then pasteurization has become general and the tendency in baby health stations has been away from accentuation of them as places for the distribution of milk toward what should be their real function—that of educational propaganda in the care and feeding of young children.

Modern baby health stations, or milk stations, therefore, are generally of two types: (1) Where the milk is modified according to certain prescribed formulæ for certain ages, either in a central laboratory or at each station, and distributed only after the baby has been examined by the physician in attendance at the baby health station, who prescribes a certain standard formula of milk for the child. In addition, individual formulæ may be made, if so prescribed. In these stations doctors and nurses are assigned to examine the babies and also to see that the mothers are instructed in all methods of baby care. (2) The second type of station is that in which whole milk is distributed in quart bottles. Each baby is examined by the doctor and an individual formula prescribed in each case. One copy of this formula is given to the mother and the other to the nurse. The nurse instructs the mother at the station how the formula should be prepared and in addition visits the home to reinstruct her until it is evident that the mother is

entirely competent to prepare the milk. The value of this method lies in (*a*) the lessened cost of the day's feeding, (*b*) the educational value to the mother in the opportunity afforded to visit her in her home and offer public health education and (*c*) the flexibility of the feeding system which insures definite attention to each child's needs.

Organization of Baby Stations.—The stations should be open from 8 A.M. to 1 P.M. daily and from 8 A.M. to noon on Saturdays for instruction and advice and from 8 A.M. to 10 A.M. on Sundays and legal holidays for the distribution of milk only.

Before establishing a station, a study should be made of those sections of the city where it is felt that the need for such organization is greatest and the following factors taken into consideration: Infant mortality-rate, birth-rate, child population, congestion of district, housing, general intelligence of parents, and economic status of population, etc. If other agencies performing similar work exist in any given district, the baby health station should be established in some other section in order to avoid duplication of effort.

The education of the laity to the importance and advisability of breast feeding should be kept foremost in the educational propaganda. Only when absolutely necessary should artificial feeding of babies be allowed or countenanced. In order to meet the situation of babies who must be artificially fed, a high grade of safe, clean milk, known in New York City as "Grade A pasteurized" should be sold in bottles, at a price usually from three to three and a half cents below the prevailing market price. In selected cases of want, milk may be provided free of cost, through the organized charities and other agencies.

The temperature of the milk should be tested daily at each station and bacteriological and chemical analyses should be made regularly in the laboratory of the board of health in order to ascertain the bacterial content and quality of the milk.

Each station should have a nurse and a nurse's assistant in attendance daily. One doctor may be provided for three stations, attending each twice a week. During the summer months the regular baby health station service should be augmented by the employment of additional nurses and doctors.

The sites selected for baby health stations should preferably be stores consisting of four rooms each: the first for a dispensing room for the distribution of milk, the second a waiting room for dressing and undressing the babies and weighing the children, the third a demonstration room for preparing milk formulæ and holding mothers' classes and the fourth a consultation room where the doctor examines the babies and instructs the mothers.

Full equipment at the stations varies somewhat with the premises available. The following list of equipment for use at the baby health stations is inclusive of all articles in the best equipped stations but a much less elaborate equipment will provide everything actually essential:

Equipment for Baby Health Station.—

1 zinc top dispensing table
1 large steel enameled table 24 x 60
1 small steel enameled table 20 x 48
1 desk, white enameled steel
1 supply closet, white enameled
1 wardrobe, white enamel
18 wooden folding chairs at $20 per dozen
3 steel white enameled chairs at $2.89 each
1 box for record cards
2 laundry bags
1 wire scrap basket
1 clock
1 scale and scoop
1 infant's bath tub
1 three-burner hot plate
1 double boiler, two quarts
1 saucepan, two quarts
1 tea kettle, three quarts
1 dishpan, fifteen quarts
1 tray, white enamel
1 strainer with hook
1 bowl, two quarts
1 funnel, half pint
1 pitcher, one quart
1 basin, white enamel
1 cup, eight ounces, with handle
1 glass jar, one quart, with cover
1 glass graduate, eight ounces
6 glass tumblers, eight ounces
1 soap dish, white eramel
Thermometers, one each, dairy, room, clinical, bath
1 can opener
6 bottle washers
6 teaspoons
6 tablespoons
6 knives
40 yards linoleum at $1.00 per yard
1 refrigerator
1 hospital screen, white enameled where necessary
4 window screens at $1.00
1 door screen
1 towel rack, wood, three-prong
1 rubber door mat
2 asbestos mats
1 ashcan, No. 9 (where necessary)
Brushes: nail, .10; scrub, .15; window, .50; sink, .10; stove, .25
1 broom
1 dustpan
1 mop, cotton twine, with handle
1 mop wringer
1 metal pail
1 coal hod (where necessary)
1 large shovel (where necessary)
1 small shovel (where necessary)
1 rubber squeegee and handle
1 stepladder
1 tool combination plier
1 fountain syringe, two quarts
1 catheter, 17-French
Shades, 4 window and 1 door at $1.50 each (where necessary)
Gas radiator (where necessary)
Stove (where necessary)

The service at the stations should be supplemented by home visits by the nurse, usually in the afternoon, when full instruction in diet, hygiene and sanitation should be given to the mother. Supplemental literature regarding baby care should be distributed as indicated. Mothers should be instructed to bring their babies to the station once a week on a given day for weighing purposes, and more frequently if the baby is ill or delicate.

If the mother fails to bring her baby on the regular weighing day, a visit to the home should be made to ascertain the cause for non-attendance and if, after reasonable warning, the mother does not bring the child to the baby health station within a period of three weeks, the case may be terminated unless the reasons are such as to satisfy the nurse in charge that the mother is unable to attend. The enrolment at the baby health station should be maintained throughout the year by house-to-house canvass of the neighborhood by the nurses and nurses' assistants.

The physicians in attendance at the baby health stations should not treat any cases of illness if the parents are able to afford the services of a private physician. Occasionally, cases of acute illness may be given emergency or first-aid treatment and then subsequently referred to the private physician, if the family is able to pay. General diseases, such as bronchitis, pneumonia, contagious diseases, etc., should not be treated under any circumstances, except as aforenoted. Cases of gastro-enteritis and of malnutrition, if unable to pay for the services of a private physician and unwilling to visit the dispensary, may be taken care of by the baby health station service.

Instruction should be given at the station in all matters of child diet and child care and each case should be treated individually by the inspector as regards milk modification. The formula prescribed by the physician in attendance should be demonstrated to the mother, both at the station and in the home, until the nurse is satisfied that the mother understands.

Aims and Objects of the Baby Health Stations.—The aims and objects of the baby health stations are:

1. To supervise expectant mothers during pregnancy, the lying-in period and for at least one month after the birth of the child, through the prenatal service of the station. The baby is then transferred to the regular baby health station service.

2. To advise mothers with regard to the care and feeding of babies under two years of age.

3. To encourage, secure and maintain, entirely or in part, breast feeding.

4. To supply, when artificial feeding is necessary, a good grade of clean, safe milk at lower than the market price, for those who are unable to pay the latter.

5. To prevent, by educational and prophylactic measures of child hygiene, the diseases of infancy and childhood caused by errors in diet and unhealthful living and, by such teaching, to minimize the possibility of illness.

6. To serve as bureaus of information or community centers to which the inhabitants of the neighborhood may come for advice and assistance regarding the health and physical welfare of the entire family.

7. To effect not only a reduction of infant morbidity and mortality but, indirectly, to promote the general good health and well-being of the entire family by bringing into the home rules for healthful living.

The main effects of the baby health stations have been the reduction of the infant death-rate from diarrheal diseases and the improvement in the general health of the infants so that the death-rates from respiratory and contagious diseases have also been materially reduced. In the registration area of the United States for 1910, diarrheal diseases furnished 29 per cent. of the deaths under one year of age, respiratory diseases 14 per cent., contagious diseases 4 per cent. and the other miscellaneous causes 21 per cent.

As the prevalence of diarrheal diseases may be considered to depend upon the extent of dietetic errors in infancy, it is evident that efforts directed toward providing a clean, natural feeding for the child are the best to use in reducing the death-rate from these causes. Whenever it is possible, without serious detriment to the mother, breast feeding should be insisted upon. It will be found that among babies of mothers of foreign parentage, breast feeding is almost universal during the first three months of the baby's life. It is stopped later, usually, because of the mother's desire to go to work or to her belief that substitute feeding is just as good for the baby. Probably 95 per cent. of the mothers are physically able to nurse their infants during the first six months. In a study made to determine the importance of breast feeding in the prevention of infant mortality conducted by the Bureau of Child Hygiene of the Department of Health of New York City some years ago, embracing about four thousand children between three and twelve months of age, it was found that 79 per cent. of these babies were breast fed exclusively, 13 per cent. were fed on bottled milk exclusively, and 8 per cent. on bottled milk and breast milk combined. It is safe to say that about 80 per cent. of the tenement population nurse their babies exclusively.

The infant death-rate, in general terms, is directly the opposite of the manner in which the babies are fed. It has been estimated that from 75 per cent. to 85 per cent. of all infant deaths occur among those artificially fed. Holt has stated that "The difference in the mortality of these two classes (breast fed and bottle fed) is most striking. The Health Department estimates that 85 per cent. of all infantile deaths are in those artificially fed. This statement is borne out by figures drawn from other sources. Tyson states that of 150,000 infantile deaths in Great Britain, 75 per cent. were in those who were artificially fed. Kober states that of 54,047 infantile deaths investigated at home and abroad, with reference to feeding, 86.6 per cent. were artifically fed. In Munich, the mortality in breast-fed babies is stated to be 15 per cent. while in bottle-fed infants it is 85 per cent."

Several investigations have been made by the Bureau of Child

Hygiene of New York City as to the character of feeding in infant deaths from diarrheal diseases. Almost invariably, it was found that of 1000 deaths from this condition, approximately 90 per cent. were babies artificially fed and 10 per cent. infants fed on the breast.

As late as last year a study was conducted by the Bureau of Child Hygiene of New York in connection with the Mayor's Milk Investigation Committee, with a view to determining the relation of the character of feeding to deaths from diarrheal diseases in infancy, and accurate information was obtained in 1065 cases, with the following results:

Character of feeding.	No. of cases.	Percentage of cases.
Breast feeding only	178	16.7
Breast and bottle	154	14.4
Breast and other	67	6.3
Breast and loose	11	1.0
Bottle only	286	26.9
Bottle and other	221	20.7
Bottle and loose	10	1.0
Loose	22	2.1
Loose and other	25	2.4
Other	91	8.5

These figures, showing 17 per cent. of the babies who died were exclusively breast fed and 83 per cent. artificially fed, offer a convincing argument for maternal nursing as a preventive, at any rate, against gastro-enteric diseases. These figures are, furthermore, corroborated in the article by Holt, who states: "Hope of Liverpool has shown that in 1000 breast-fed infants under three months of age, there were only 20 deaths from diarrheal diseases, while of 1000 bottle-fed infants there were 300 deaths. Of 1000 fatal cases of diarrheal diseases investigated by the New York Department of Health in 1908, only 90 had previously been entirely breast fed. Newsholme gives almost the identical figures for England, namely, 10 per cent. of infant deaths from diarrheal diseases in breast-fed infants and 90 per cent. in bottle-fed infants."

If artificial feeding must be resorted to, cows' milk of the highest grade, certified if raw or pasteurized if any doubt exists as to the conditions under which it was produced, should be used as the basis for feeding, and should be modified to suit the needs of each individual child. Methods and types of modification may be left to the discretion of the individual physician. In New York City dilution of whole milk, with the addition of the required amount of milk sugar and lime water, has proved peculiarly efficacious.

Methods of computing mortality in the baby health stations have been open to question. The usual method is to consider the station as responsible for the death of a baby when it occurs at any time from illness contracted while on register at the station. The variability of standards in this direction, however, has given rise to a great deal of misconception in this regard. It is probable that percentage statistics of this type are no more than an indication of the effect of the station

upon the reduction of infant mortality. Other methods have been advised and suggested from time to time, notably that of computing the total number of days' attendance at the baby health station, dividing this by 365, the number of days in a year, and then computing the death-rate for the year on the so-called "infant days" or the number of days the infants were in attendance. This method has its disadvantages in that it does not take cognizance of the educational value of the stations and the fact that their effects may be expected to be more potent when the babies have been in attendance for some time, also that the baby health station is in no sense a clinic, so that children in attendance for a short time who die of acute disease do not truly represent the value of the station's methods. However, this method may be accepted at the present time as only one of the standard means of determining the death-rate at such stations.

While the death-rate based upon the actual deaths of infants computed on the total attendance may range from 10 to 25 per thousand, the death-rates based upon the infant year plan have shown a death-rate of 42 per thousand in the Baby Health Stations of New York City, whereas the total infant death-rate for the city for the same year was 93. Even this severe test shows that the baby health station, as a measure in reducing the infant mortality-rate, has justified itself. Where they have been used in large numbers the effect upon the infant mortality-rate has been immediate and progressive. The baby health station of the future, should be planned so that its functions may include supervision of the health of the child from birth to school age. It should be a community health center for young children. The prominence of milk as a factor in the reduction of infant mortality from the baby health station point of view should be continually minimized. The provision of a safe milk supply in the city must be accentuated. As soon as it is obtainable the baby health stations should be educational centers only, and milk should be bought at other available places. This work can be carried on at an average cost varying from sixty cents to a dollar and a half per month per baby

Home Visiting by Nurses.—One of the defects of the baby health stations is the fact that the ages of their clientele average between four and six months of age at the time of admission. For the purpose of furnishing more adequate health education of the mothers, therefore, the visiting nurse may be used. While it is true that a nurse in a baby health station may see more mothers in a day than she could visit in the same space of time, it is also true that unless the community consists of widely-scattered dwelling places the nurse doing home visiting may care for at least one hundred and fifty babies, each to be visited once in ten days. The proper method is to have the nurse receive a copy of all birth certificates filed the previous day and relating to babies in her district. These children should be visited at once. Depending upon the length of time allowed by law for reporting births, it may be seen that such children would be visited from three to ten days after birth, at a time when breast feeding is practically universal

and when there is every opportunity to give the mother the proper type of instruction in caring for her baby. A visit once in ten days is adequate for the normal child. Sick or delicate babies should be visited more often. At each visit the mother should be instructed as to the value of breast feeding and should be given definite and detailed instruction and demonstration as to the hygiene of infancy, including clothing, bathing and the value of fresh air, as well as instruction pertaining to the hygiene and sanitation of the home. This plan of work has certain distinct advantages: (1) It enables the nurse to reach the parents almost as soon as the baby is born and (2) it is distinctly less costly than the establishment of baby health stations. It has been found possible to carry on this work at a total cost of from fifty to sixty cents per month for each baby cared for. It has the disadvantage, however, of not providing any place where mothers may bring their children at any time with the surety of finding some person to advise them and it lacks the educational advantages which result from the publicity given a local baby health station or baby welfare center. For small towns, however, it offers an opportunity for effective work if funds cannot be raised at once to establish a baby health station.

Conferences of Mothers.—As part of a well defined program for the reduction of infant mortality, arrangements should be made whereby conferences can be held with groups of mothers at stated intervals. These conferences should be presided over by a physician or nurse and the mothers should be given direct, practical talks, with actual demonstration of different methods of child care. While this holding of conferences has a distinct value, they should not be conducted at the cost of more effective baby welfare work in other directions. They must be considered as an auxiliary only.

Little Mothers' Leagues.—Little Mothers' Leagues originated in the Bureau of Child Hygiene of New York City in 1910 as a result of the realization that a large number of the babies of the city are cared for by little girls of from ten to thirteen years of age. As the social and economic conditions in the city seemed to make this inevitable, it was felt that these children should be taught how to care for babies, not only to provide the proper care for the children under their control at that time but also that they might in turn carry these instructions to their mothers and, most important of all, that they might receive instruction which would enable them to care for their own children later.

The organization of these leagues can be accomplished as follows:

First, the public should be informed regarding the proposed leagues by (*a*) a general public lecture or (*b*) separate lectures in each public school of the city. It is recommended that girls from ten to fourteen years of age be considered eligible. If such instruction in personal hygiene and care of the baby can be made part of the regular school curriculum, such a course should be taken. Only in the event of the refusal or inability of the school authorities to provide this teaching should the work be assumed by the health authorities. In such case,

the leagues may well be held only from the closing of school in the late spring to their reopening in the fall. If possible, however, they should be conducted throughout the year.

At the preliminary meeting, the children should be asked to become voluntary aids of the board of health in saving the lives of babies and should be required to sign pledge cards signifying their intention to attend the meetings. At the first meeting of the children the organization may be effected, with the nurse as honorary president and two of the children elected president and secretary. An outline of the business meetings may be evolved to suit local needs. In general, however, at each meeting there should be a short talk by the nurse on some one method of baby care, to be followed by actual demonstration. Each child should be required to perform the actual work of milk modification, dressing or bathing the baby, until it is evident that it is well done. Several lessons may be spent on one topic. The lessons that are suggested herewith are merely advisory for a short course. They may be extended to include various other subjects, including personal hygiene of the girls themselves.

SUGGESTED LESSONS FOR LITTLE MOTHERS' LEAGUES.

1. Growth and development; special senses.
2. Teeth.
3. Water—internally and externally; special baths.
4. Fresh air.
5. Sleep and quiet.
6. Clothing and cleanliness.
7. First care of sick baby.
8. Difference between mothers' milk and cows' milk.
9. Amount and intervals of feeding.
10. Care of milk; bottles; nipples. Articles needed for home modification of milk.
11. Directions for home modification of milk.
12. Instructions for making albumen water; whey.
13. Quiz on previous lessons.

The children should be encouraged to write essays about the lesson topics and also to write descriptive plays, illustrating the various points they have learned. These plays should be acted by the members of the leagues. This method furnishes a graphic form of teaching, which has been found to be unusually successful. Many ways of developing the Little Mothers' League will present themselves to any interested person. The work should be made as joyous as possible and the children encouraged to have picnics, outings or other forms of entertainments which will take away from the leagues the idea of an auxiliary school. Simple equipment is necessary and may be modified to suit the needs of the various localities. The following is suggested:

EQUIPMENT FOR LITTLE MOTHERS' LEAGUES.

Gas stove and tubing.
Bathtub.
Double boiler.
Dish pan, two quarts.
Bowl, two quarts.
Tea kettle, two quarts.
Pitcher, one quart.
Tumbler.
Glass graduate, eight ounces.
Funnel.
Scale.
Basket.
Strainer.
Bath thermometer.
Clinical thermometer.
Baby bottles, four 8-ounce.
Nipples, four.
Knife.
Tablespoon.
Toothbrush.
Safety pins.
Piece of castile soap.
Piece of rubber sheeting or pad.
Bath towels, two.
Face towels, two.
One pound package absorbent cotton.
Five yard package gauze.
Rice or starch powder.
One-half pound borax.
One-quarter pound mustard.
One package Robinson's Prepared Barley.
Milk sugar.
Lime water.
Toothpicks.
Small bag of salt.
Bag of bran.
Pad for scale.
Tissue paper.
Large size washable doll.
Quilted padding, five yards, to make cheap mattress and pillow.
Enameled cup or saucepan, with cover, one-half pint.

Public Health Education.—The subject of proper education of the mothers in infant care varies with the type of locality. In country or rural districts where visiting nurses are not available, or may be seen only at widely separated intervals, pamphlets of instruction on infant care should be detailed and elaborate. It is permissible in such pamphlets

to give positive instruction as to infant feeding, with samples of the formulæ. In communities where public health nurses are available, however, pamphlets on infant care should consist only of broad principles of instruction. The details should be left to the public health nurse to carry to the individual family and should be suited to the individual case. It is probable, also, that in large cities at least 75 per cent. of the people who must be reached in order that public health education may be effective cannot be reached by the written word. They must have direct personal instruction. This may be brought to them (1) through the visiting nurse and (2), of course to a much less effective extent, through the young children of the family. This latter method, however, should not be underestimated. The value of teaching school children the truths of hygiene and well-being and having these facts transmitted to the family has proved to be of great value. In the same way the teaching of young girls regarding the care of children is an excellent method of having such teaching carried to the real mother. Newspaper articles are mainly valuable for their general interest to the public, although in certain localities it has been found that weekly articles on different phases of baby care have a distinct value. This method has been tried out more consistently in New Zealand than anywhere else. In that country each newspaper publishes once a week a column under the general heading of "The Baby." Material for this column is furnished by the New Zealand Society for the Health of Women and Children, which is a quasi-governmental organization. If printed pamphlets are used, emphasis should be placed upon the constructive rather than the destructive side. "Do's" have a far greater value than dont's. Effort should be made to tell the mothers how to take care of their babies rather than how to avoid doing what is wrong.

Auxiliary Aids: Coöperation of Baby Welfare Organizations.—It must be recognized in the beginning that infant mortality is an exceedingly complex problem, therefore any public or private organization which in any way works for the welfare of the baby should work in close coöperation with the authorities that are endeavoring to lower the infant morbidity- and mortality-rates. In many cities there has been great duplication of effort, overlapping of work caused by this lack of coöperation. Health officers should consider that as public officials it is their duty to correlate the work of all private health organizations in the community. This in no way need interfere with the integrity or effective working of any institution. It simply affords a means whereby the full measure of coöperation may be obtained.

It is necessary for the infant welfare nurse, as well as the child welfare nurse, to have an intimate knowledge of the facilities at their disposal. Quick results in obtaining material relief or in adjusting social problems are essential in reducing the baby death-rate. Such facilities, therefore, should be encouraged and extended and made use of by the health officer.

CARE OF ABANDONED OR ILLEGITIMATE CHILDREN.

The high death-rate among babies born out of wedlock has already been mentioned. This probably accounts to a certain extent for the high death-rate occurring in institutions for foundling babies. These institutions also receive abandoned children born in wedlock who necessarily suffer much from the privations they have met with before being received into the institutions. Notwithstanding these two facts, however, the death-rate of institutions for foundling babies has remained so abnormally high that it has become a very definite factor in the infant death-rate and must be considered in any effort to reduce such a rate.

It has been found that institutionalism, *per se*, has a serious effect upon the health of very young babies. The regularity of the life and the absence of the human and individual element in baby care seems to be the important factor. This point of view has received marked support because of the marked reduction in the death-rate as a result of taking these infants from the institutions and giving them out to board in private families. In order that this may be carried out safely, however, no woman should be allowed to board a child until she has received a permit therefor from the local board of health allowing her to do so. Before this permit is granted the woman and her surroundings should be carefully inspected by a physician from the board of health, this report determining whether or not the permit should be granted. The following items may be looked for:

1. Nature of the premises.
2. Number of rooms.
3. Number of persons in the family, including number of children and their ages.
4. Number of boarders (adults and children).
5. If any infectious diseases are present.
6. Sanitary condition of the house and of the rooms occupied by applicant.
7. Light and ventilation of rooms.
8. Personal appearance and health of applicant.
9. Condition of child (if already boarded).
10. Character of feeding (breast or artificial).
11. In case the applicant intends to breast-feed the child, the inspector notes:
    (*a*) Name of applicant's last child.
    (*b*) Date and place of its birth.
    (*c*) Name and address of physician or midwife in attendance at the birth.
    (*d*) Date, place and cause of child's death.
    (*e*) Names and addresses of the attending physician and undertaker.
12. Race, religion and color of applicant.
13. Grade of home, based on sanitation and surroundings.
14. Class of home, whether suited for breast-fed or bottle-fed infants, children under two years or children from two to six years.

When a boarded-out baby is being breast-fed, the main points to be considered are the health and natural ability of the foster mother. If the baby is to be artificially fed, however, more stringent attention must be paid to the sanitary surroundings. Such babies must be carefully supervised in order that there may be no abuse. The following regulations are advised:

REGULATIONS GOVERNING THE BOARD AND CARE OF CHILDREN.

Regulation 1.—Applicant must specify whether she intends to act as wet or dry nurse. The applicant for a permit must specify whether she intends to act as a wet nurse or as a dry nurse.

Regulation 2.—Quality and quantity of milk to be adequate and suitable. A permit for wet nursing will not be issued unless the quantity of milk is adequate and the quality of milk is suitable. If at any time after the issuance of the permit the quantity of the milk is inadequate or the quality of milk is unsuitable, such permit will be immediately revoked.

Regulation 3.—Personal attention required. The person to whom a permit is issued must give personal attention to the proper feeding, care and hygiene of the child or children entrusted to her care and control.

Regulation 4.—Children to be always attended. The child or children must never be left without an attendant.

Regulation 5.—Rooms to be kept clean and sanitary. The rooms must be well ventilated, clean and sanitary and must be kept in an orderly and neat condition.

Regulation 6.—Excess boarders forbidden. No greater number of children than the terms of the permit allow shall be received, boarded or kept.

Regulation 7.—Notice of removal. It shall be the duty of any person to whom a permit has been granted to immediately notify the board of health in the event of removal to another address or to another apartment at the same address.

Regulation 8.—Notice of illness. If the child is taken ill, the parent or the institution from which the child was obtained shall be immediately notified, and the child should be treated by a private physician or at a hospital or dispensary or the board of health notified immediately of such illness.

Regulation 9.—Care of sore eyes. If a child's eyes become sore, they should be treated by a private physician or at a hospital or dispensary or the board of health notified immediately of such fact.

Regulation 10.—Permits. The permit is issued for the period of one year and may be revoked by the board of health at any time for violation of any of these regulations.

Regulation 11.—Register. Every person holding a permit to board and care for children must keep a register wherein he or she shall enter the names and ages of all such children, the names and residences

of their parents as far as known, the time of the reception and discharge of such children and the reasons therefor, and also a correct register of the name and age of every child under the age of five years who is given out, adopted, taken away, or indentured from such place to or by anyone, together with the name and residence of the person so adopting, taking or indenturing such child, and shall cause a correct copy of such register to be sent to the board of health within forty-eight hours after such child is so given out, adopted, taken away, or indentured. Such register shall be supplied by the board of health to all such persons.

Experience has shown that these babies boarded out in private homes have greater chances of life than those kept in institutions. Marked reduction in the death-rate has been shown in all instances coming under the writer's observation.

SUPERVISION OF THE CHILD OF PRE-SCHOOL AGE.

This has been the most neglected period of child life so far as public health is concerned. The reason probably lies in the difficulty with which these children can be reached. The birth certificate furnishes the point of attack for the work for the reduction of infant mortality and the schools furnish a ready clearing-house for health supervision of children of school age. There is no such easy means for the supervision of the health of the child between two and five years of age.

Within recent years special efforts have been made to see that these children receive the same health care as children of the younger and older ages. As an age group, health supervision at this time of life is particularly important. The contagious diseases of childhood are particularly noticeable during this period. In the registration area ninety-five out of every one hundred deaths from whooping-cough occurred under five years of age, eighty out of every one hundred deaths from measles, sixty-two per one hundred of all deaths from diphtheria and fifty-four per one hundred of all deaths from scarlet fever occurred in children under five years of age. Studies made of the occurrence of physical defects in children of this age group show that, with the possible exception of defective vision, the proportion of the various types of physical defects are much greater during the pre-school age than during later child life. The pre-school age, from the health point of view, bears the same relation to the health of the school child as the prenatal period bears to the child after birth. Adequate health supervision during infancy may provide the basis of good health so that the child may be more resistant to disease during the pre-school age period, but health supervision should not relax for this reason. If we carry our efforts in preventive medicine to their logical conclusion, the time to prevent the defects of school children is during their pre-school age period. The death-rate in this age group from all causes is extremely high, amounting in the registration area to one out of every four

deaths reported at all ages. For this reason the health program should include methods of supervision of the pre-school age child.

Health Centers.—Baby health stations, as described previously, should be used as health centers for this age group. Children of this age should be canvassed for and registered. They may be referred by various agencies or the parents may be reached directly through publicity. Each child should be thoroughly examined and all physical defects and abnormalities noted. The cases should then be referred to the health center nurse whose duty it is to consult with the mother regarding the type of care the child needs. The nurse should also make as many home visits as may be necessary to see that her instructions are carried out. Unfortunately, sanitary and hygienic conditions have a marked effect upon the children of this age group and efforts to reduce the death-rate under five are quite as important as the effort reduce the death-rate under one.

Day Nurseries.—A direct method of supervision of the pre-school age child is offered by the day nursery. These institutions, which were first established in France about the middle of the last century, have not only a marked value in caring for the child but have great educational value to the parent. Owing to the commercial possibilities in the day nursery, however, they should be carefully supervised from the health point of view. No such day nursery should be conducted in any town without a permit from the board of health and in accordance with the regulations of such board. The following regulations are recommended:

REGULATIONS FOR DAY NURSERIES.

Regulation 1.—Inspection of children on admission. Each child must be inspected on admission and if suspicious signs of contagious disease are noted the child must be placed in the isolation room and kept entirely apart from the other children and the board of health notified at once.

Regulation 2.—Isolation room to be provided. An isolation room for cases of suspected contagious diseases shall be provided.

Regulation 3.—Rooms to be above street level. All rooms devoted to nursery or kindergarten purposes shall be above the street level unless there is a cellar underneath the room so occupied.

Regulation 4.—Premises to be kept clean. The premises shall at all times be kept in a clean and sanitary condition. Dry dusting or sweeping is prohibited.

Regulation 5.—Ventilation, light and heat. Adequate ventilation, lighting and heating shall be provided. Except in extremely cold weather, adequate ventilation must be maintained by means of open windows.

Regulation 6.—Ventilation for outer garments. A well ventilated room for children's outer garments shall be provided. In this room the clothing removed from the children in the morning must be placed.

Regulation 7.—Air space. A minimum of two hundred cubic feet of air space for each child shall be provided.

Regulation 8.—Floor space. Each iron bed or crib shall be placed so that there will be a space of two feet on all sides except where the head or sides of a bed or crib may touch the wall.

Regulation 9.—Wire springs to be used; mattresses prohibited. Woven iron springs shall be provided, over which a folded blanket, protected by rubber or oilcloth sheeting, must be placed. Mattresses are not allowed.

Regulation 10.—Use of common wash clothes, etc., prohibited. The use of common wash cloths, towels, combs and hair brushes is prohibited.

Regulation 11.—Diapers to be washed. All diapers that have become soiled during the day shall be immediately placed in water and thereafter thoroughly washed and boiled. No diapers in an unclean condition shall be removed from the premises.

Regulation 12.—Over-aprons to be provided. Unless the clothing worn by a child is thoroughly clean on admission, a suitable over-apron (the property of the day nursery) shall be worn through the day, and each individual apron shall be marked for identification, unless a clean apron is provided daily.

Regulation 13.—Care of milk, etc. Adequate care must be taken of the milk, bottles and nipples used in infant feeding.

Regulation 14.—Excess admissions forbidden. No more children shall be admitted daily than are allowed by the permit of the board of health.

Regulation 15.—Physician to be attached to nursery. Each day nursery shall have attached thereto a regular physician of its selection, duly licensed under the laws of the State, and in good professional standing, and immediately upon the appointment of said physician the day nursery shall notify the board of health of the name and address of said physician.

It shall be the duty of such physician:

(*a*) To make a systematic examination of every regularly attending child at least twice a month, said examinations to be made at least two weeks apart.

(*b*) To examine each child applying for admission and if suspicious signs of infectious disease are noted, to have such child placed in the isolation room, separate and apart from other children, and immediately notify the board of health, or if such child is found free from infectious disease, to issue a certificate to that effect and deliver same to the matron in charge of the nursery.

To take a vaginal smear from each female child applying for admission where there is discharge from the vagina. This smear should be sent to the board of health for examination and a certificate of admission as provided in section (*b*) of this regulation should not be issued unless the result of the examination of such smear is negative.

Regulation 16.—Duties of matron. It shall be the duty of the matron in charge of each day nursery:

(*a*) To have on file, in the office of the nursery, an original certificate of health, signed by the nursery physician, for each child that is a regular attendant.

(*b*) To have on file, in the office of the nursery, a record that each child regularly attending has been examined by the nursery physician at least twice a month, the said examinations being not less than two weeks apart.

(*c*) To prevent the admission to the nursery of children who have not been examined by the nursery physician and to whom a certificate to the effect that they are free from infectious disease has not been issued.

(*d*) To notify the board of health and the nursery physician immediately, by telephone, of any suspicious rash or illness which appears among the children, during the absence of the nursery physician, and to isolate any child or children so affected in the isolation room.

(*e*) To make daily inquiry of each mother or other person bringing the child as to whether or not any sickness exists in the child's home, and if any suspicion is aroused as to the possibility of such home sickness being of an infectious nature, the child shall be excluded and the board of health notified, and such exclusion shall continue until a certificate of the board of health is furnished to the effect that the premises referred to are free from infectious disease.

(*f*) To require that every certificate of health for a female child shall not be considered complete unless attached thereto is a certificate of the board of health to the effect that the examination of the vaginal smear is negative.

(*g*) To exclude any female child who has been shown by examination of a vaginal smear to be affected with gonorrheal vaginitis unless accompanied by a certificate of the board of health to the effect that two smears taken on successive days have shown negative results.

(*h*) To enforce all rules and regulations of the board of health for the conduct of day nurseries in so far as they relate to heating, lighting, ventilation, cleanliness and general sanitary condition of the day nursery under her charge, and the care and maintenance of the attending children and their clothing, and the character and method of preservation of food.

SCHOOL MEDICAL INSPECTION AND HYGIENE.

History of School Medical Inspection.—The first instance of health supervision of school children occurred in France where, by the law of 1833 and a Royal Ordinance of 1837, the school authorities were charged with the duty of providing sanitary condition of school premises and supervision of the health of the children. Very little work was undertaken in this regard and it was not until 1842 that the government issued a decree that all public schools in Paris must be

inspected by physicians. School medical inspection as it is in effect at the present time did not actually commence in Paris until 1897. Germany was the second country to institute a system of health supervision of school children. This occurred in 1867 in Dresden, where annual tests of vision were required. Real school medical inspection in that country, however, began at Frankfort-on-Main in 1889. The dates of installation of this system in the indicated countries are as follows:

France	1833
Germany	1867
Sweden	1868
Russia	1871
Austria	1873
Belgium	1874
Egypt (Cairo)	1882
Norway	1885
Argentine Republic and Chile	1888
England (London)	1891
United States	1894
Mexico	1896
Japan	1898
Bulgaria	1904
Australia	1906
Tasmania	1906
Canada (Montreal)	1906

In the United States, school medical inspection was started in the City of Boston in 1894 where, on account of an epidemic of diphtheria, it was found necessary to send physicians into the public schools to limit the spread of the infection. While in Europe the general health of the child was taken as the basis for the first systems of school medical inspection, in the United States the desire to limit the spread of infectious disease was the compelling motive. Philadelphia was the second city to institute this system—in 1895—while New York City began its work in 1897. At the present time systems of school medical inspection are in effect generally throughout the United States. Twelve States have mandatory laws which make school medical inspection obligatory in the various cities and towns. These States are Massachusetts, District of Columbia, New Jersey, Colorado, Maine, Minnesota, Louisiana, New York, Pennsylvania, Rhode Island, Utah and West Virginia. Twenty-two States have permissive laws, authorizing any towns to assign school physicians if they choose to do so. In addition to these, a considerable number of cities and towns carry on a system of school medical inspection with the authority of local ordinances or occasionally without any legislation.

School Medical Inspection as Part of the Health Program.—All early systems of school medical inspection in this country were placed under the local health boards, with the distinct recognition that the health control of children is a health and not an educational matter. The matter of placing this work under either health or educational authorities is one which has received much attention for many years. In the United States, out of thirty-four States which have laws requiring

or permitting the employment of medical inspectors, twenty-nine have the work definitely under the State board of health. In four it is under the State board of education, while in one State the two boards administer the work jointly. In general, a great proportion of the large cities have the work under the control of the State boards of health, while smaller towns and rural communities are more generally under the supervision of the educational authorities. The reason for this seems to be a local one. In large cities, health boards are usually well organized and have adequate machinery for carrying on so extensive a program as the health supervision of children of school age. In small towns and rural communities where the value of health work has not been properly recognized, the health officer is frequently a part-time employee, with no administrative machinery at his disposal. For this reason school boards, which are usually well organized even in the smallest places, have been in a position to initiate the work. School authorities, generally, take the point of view that the conservation of the health of the child is distinctly their responsibility and part of the general educational program. They also claim that as they have the buildings and the children under their immediate supervision, there would be less friction and greater efficiency if the health supervision were controlled by them. Health authorities generally view the problem of child health as part of any coördinated program for the conservation of the health of all persons in the community. As the age group under fifteen is potentially the best field for public health work and also the age group where immediate health measures are probably most needed because of the high mortality- and morbidity-rates, health boards should not be allowed to delegate this responsibility to any other authority. To assume that a health board can care for the health of the population under six years of age and then neglect such health measures until the individual has reached the age of fifteen implies a neglect of opportunity which should be condemned. Health work for children furnishes such an important part of the entire health propaganda that it should assume a position of first importance in the program of all health activities. In small towns, however, where health boards are unable to assume any responsibility except the most superficial control of contagious diseases, this work may be undertaken by boards of education. It must be kept in mind, however, that the average school is open only about one hundred and ninety days of the year and that during those one hundred and ninety days the child is under control of the school authorities for only five out of the twenty-four hours. Under school control, therefore, the child is without health supervision for the greater part of the year.

School Medical Inspection Organization.—The health director or chief school medical inspector should devote his entire time to the service. The field inspector or school doctor may preferably give part time to the service and an average of three hours each school day should be required. While, theoretically, the school doctor may be assumed to offer better service if he has no other occupation, it has been found

that with the small salaries paid for this position it is not possible to secure the type of service desired. Another and even more weighty objection is that exclusive work of this kind, without the inspiration afforded by general outside medical work, tends toward a narrowing of interests and routine work. The full-time health director should be paid a salary of from $3000 to $5000 a year, according to the population of the community. The school inspectors' salaries show a wide variation in different localities, but from $80 to $100 per month should be a minimum standard. Nurses' salaries are at present at too low an average, seventy-five dollars or less a month being the accepted rate. The work of the school nurses has broadened immeasurably since they were first employed and while the present rate may be adequate for small towns and rural districts, a minimum salary of one hundred dollars a month should be established for cities.

The ideal system would provide one physician for each three to four thousand children and one nurse to each twenty-five hundred to three thousand children. Such ideal conditions, however, can be found in but few places at the present time and the ratio of from five to nine thousand children to each physician and from three to five thousand children to each nurse is more commonly encountered.

Types of School Medical Inspection.—Four types of school medical inspection are recognized:

(*a*) Those using physicians alone.
(*b*) Those using physicians and nurses.
(*c*) Those using nurses alone.
(*d*) General supervision by teachers.

(*a*) The employment of a school physician without a nurse is of doubtful value as the results of such procedure are usually only statistical and lack of adequate follow-up work usually results in very little benefit to the children.

(*b*) In systems using both physicians and nurses, the physicians are generally used for the diagnosis of contagious diseases and the physical examination of the children, the nurses carrying out routine inspection in the classroom, assisting the physicians and being responsible for the follow-up work in the homes to see that the physical defects are corrected. Any of these functions may be delegated to either physician or nurse. It has been found entirely feasible in New York City to have the nurse do all of the early detection of symptoms of contagious diseases, the reason for this being that nurses are trained to detect symptoms and the value of school supervision of infectious diseases lies in their early detection and exclusion from school rather than waiting until a final diagnosis can be made.

(*c*) Particularly in small communities, it is possible to employ a nurse without a physician. This nurse, acting in close coöperation with the teacher, is not only able to detect the early symptoms of contagious diseases but also it is possible for her to determine those children who are apparently suffering from physical defects. Such children should be referred to their private physicians for diagnosis

and treatment. If it is possible to employ only one person in any system of school medical inspection, this one person should be a nurse.

(*d*) In any assignment of forces, the teacher must be considered as a valuable adjunct. Her close contact with the children makes her the first line of defense in the discovery of abnormal health conditions and she may readily be instructed in the methods of detecting defects of sight, hearing, teeth or nasopharynx, as well as nervous, orthopedic or nutritional disorders. She must be relied upon in all instances to detect the earliest symptoms of illness which may prove to be of infectious origin and, in rural communities, where the visits of the school doctor and nurse are made at infrequent intervals, she will prove of great assistance in making periodic health surveys, both of the school and its surroundings and of the pupils.

Routine of School Medical Inspection.—The general routine of the school medical inspection system must vary in accordance with the number of children to be supervised, the distances between schools and the size of the medical and nursing staffs. The following outline is recommended and should be followed as closely as possible:

1. Sanitary survey of school building, surroundings and equipment at the beginning of each term.

2. Yearly testing of vision and hearing of all pupils (by nurse or teacher).

3. Daily inspection of all pupils in each classroom by class teacher, this inspection to take place at the opening of the morning session, the teacher to refer at once to the doctor's room all children who show any symptoms of any illness or physical abnormality.

4. Periodic lectures to teachers (at least once a month) to be given by the school doctor or nurse on the topic of school or child hygiene and the early detection of symptoms of illness.

5. Daily visit to each school by the doctor or nurse. At this visit the following children should be examined and appropriate action taken:

(*a*) All children referred by teachers as showing symptoms of illness or physical defects:

(*b*) All children who have been previously excluded from school attendance.

(*c*) All children who have returned to school after any unexplained absence.

6. Routine inspection of all pupils in the school, at the beginning of each term, by the school doctor and once each month thereafter by the school nurse.

7. Physical examination of each child in the following order:

(*a*) Children entering school for the first time.

(*b*) Children referred by the nurse or teacher.

(*c*) All other children in the school, proceeding grade by grade.

8. Regular visits by the school nurse to:

(*a*) Treat all cases of mild forms of contagious eye and skin diseases, allowing the children to remain in school attendance while under treatment.

(*b*) Treat minor injuries by means of first aid, such cases to be thereafter referred to their parents to provide the necessary care.

(*c*) Confer with teachers regarding health conditions of the children and the readjustment of school surroundings.

9. Visits by the nurse to the homes of children suffering from physical defects whose parents have neglected to provide proper care. At these visits the nurse should instruct and advise parents regarding the need of treatment and the hygiene of the home and of the child.

Contagious Diseases.—The control of contagious diseases in school children includes proper supervision of the hygiene of the school and its maintenance as well as the detection of symptoms at the earliest possible moment.

The school building and its maintenance deserve first consideration. Classrooms should be large enough to provide at least three hundred cubic feet of air space for each pupil. Each room should have direct sunlight at some period of the school day. Each child should have an individual desk with aisles at least two feet wide between the rows. Dry sweeping and dusting must be prohibited and proper oil dressing provided for the floors. Pencils should be individual and collected at the end of each day, in separate stout manila envelopes, marked with the name of the child, so that distribution may be made each morning. Lastly, and most important, free ventilation with the provision of air at the right temperature and degree of humidity is imperative.

In the school building, cloakrooms with individual ventilated lockers or hooks placed at wide enough intervals so that the children's outer garments shall not be in contact, are essential. The further installation of drinking fountains or the use of the individual drinking cup, the elimination of the common towel and the provision of adequate and cleanly toilet and washing facilities will all provide the needed surety of the first line of defense against the spread of infection in the school.

The main control for the prevention of the spread of communicable diseases in schools is dependent upon the system of school medical inspection. It is evident that such a system, to be effective, must rely upon such an early detection of symptoms which may indicate the onset of a communicable disease that the child may be excluded from school attendance and properly isolated at home before he has had an opportunity of infecting others. In other words the child must be excluded "on suspicion." If we wait until an accurate diagnosis can be made, the harm has already been done.

Each day each school should receive a printed list of all cases of communicable diseases reported to the Department of Health on the previous day. At the opening of the school session, this list, with a special blank book, should be sent to each classroom, where the teacher should enter the name of each pupil in the class who is noted on the list or who is a member of the family of any patient. Such children should be excluded from school at once to await the action of the division of contagious diseases of the department of health. The book is then returned to the school nurse, who reports each day to the school inspec-

tor where two or more cases of any one communicable disease have occurred in any one classroom. Thereafter, the inspector visits that class each morning, examining each child for any evidence of illness and excluding suspicious cases. If the disease is diphtheria, cultures are taken from the throats of all pupils and all cases showing the presence of the diphtheria bacillus are excluded.

The teachers should be instructed to send to the doctor's room, as soon as the classes assemble, every child who shows any evidence of illness in any form. The doctor or nurse should examine these children in a room set apart for this purpose. At this time any child who shows any symptoms which might indicate the development of a communicable disease should be excluded from school attendance. Cultures are taken in every case of sore-throat and the child excluded. Within twenty-four hours the child should be visited at his home by a medical inspector, who makes the diagnosis, either isolating the case and transferring it to the supervision of the division of contagious diseases which thereupon assumes control, or, if no communicable disease has developed, allowing the child to return to school. In New York City about 80 per cent. of the excluded children are found to have true cases of communicable diseases. The loss of one day's schooling for the remaining 20 per cent. is of small consequence when compared with the effectiveness of this early exclusion.

The early detection of tuberculosis results from observation of children who have been losing weight, appear flushed or hectic, with or without an accompanying cough, and who are designated as suspicious cases by the school doctor as a result of his regular physical examination.

Schools should not be closed during the progress of an epidemic of infectious disease. School contact instances of infection are rare. If the system of school medical inspection is at all adequate, the presence of the children in the classroom where they can be systematically observed for symptoms of approaching illness offers a far greater degree of safety to the child and protection to the other children than can be obtained by allowing the children to be in their homes or on the street in indiscriminate contact with other children. It also offers an opportunity of instituting early isolation of any cases of infectious diseases, thus limiting the spread of the infection, a procedure which is impossible if children are at home or on the streets and utterly without supervision.

Contagious Eye and Skin Diseases.—It has been amply demonstrated that the majority of children affected with contagious eye and skin diseases may be kept in school without danger to the other children as long as they continue under regular treatment. Each such case found should be given a notice to be taken to the parent or guardian, informing him that the child has a contagious disease of the skin or eyes and that unless such condition receives prompt treatment the child will be excluded from school, with the further advice that the child be taken, with this notice, to the family physician for treatment.

If on the morning of the following day it is evident that the child has obtained treatment, he should be allowed to remain in school but

required to report to the nurse at regular intervals and unless evidence of continued treatment is shown should be excluded from school attendance until the disease has disappeared.

Where no treatment has been obtained, the following method is advised:

(*a*) Cases to be excluded:

1. Contagious eye diseases with symptoms of acute inflammation or discharge.
2. Contagious skin diseases with extensive lesions.
3. Pediculosis with live pediculi.

(*b*) Cases which may be allowed to attend school while under treatment by a private physician, dispensary or the school nurse:

1. Acute conjunctivitis.
2. Pediculosis with no live pediculi.
3. Skin diseases, including ringworm of scalp, face or body, scabies, favus, impetigo, molluscum contagiosum.
4. Cases of trachoma should be instructed as to the necessity of treatment and required to report to the nurse at regular intervals to see that such treatment is maintained. However, they should never be treated by the nurse.

Circulars giving instructions as to methods of home treatment of pediculosis and also as to the care needed in cases of trachoma should be prepared and sent to the family of each child affected.

The methods of procedure to be followed by the school nurse in treatment of eye and skin diseases may be readily outlined by the health board and should be followed in each instance. The following are suggested:

Methods of Treatment of Contagious Eye and Skin Diseases to be Employed by the School Nurse.

Favus; Ringworm of Scalp.—Mild Cases.—Scrub with tincture of green soap and cover with flexible collodion.

Severe Cases.—Scrub with tincture of green soap, paint with tincture of iodine and cover with flexible collodion.

Ringworm of Face and Body.—Wash with tincture of green soap and cover with flexible collodion.

Scabies.—Wash with tincture of green soap and apply sulphur ointment.

Impetigo.—Remove crusts with tincture of green soap and apply white precipitate ointment (ammon. hydrarg.).

Molluscum Contagiosum.—Express contents. Apply tincture of iodine on cotton-covered toothpick.

Conjunctivitis.—Irrigate with solution of boric acid.

Pediculosis.—Saturate scalp and hair with mixture of equal parts kerosene and sweet oil. Next day wash with a solution of potassium carbonate (one teaspoonful to one quart of water), followed by soap and water.

In general the principle of these treatments is protection of the affected so that the infectious material may not be transmitted.

In New York City this method of care has reduced the exclusions for this cause from 57,000 in 1903 to less than 5000 in 1914, and no instance of spread of infection in the schools has occurred during that time.

Routine Inspection.—At the beginning of each term the medical inspector should make a routine classroom inspection of each child in the school. Thereafter the nurse should make the routine class inspection at least once a month, following the same procedure.

The inspector should stand with his back toward the light from a window and the children should pass in line in front of him. The condition of the eyelids, throat, skin and hair of each pupil must be observed. The inspector or nurse should not touch the child but the latter must be instructed to pull down the eyelids, open the mouth, show the hands and, in the case of girls, lift up the back hair. Wooden tongue depressors should be furnished and a separate one used for each child when such use is indicated.

Whenever a child shows symptoms of any diseased condition, that fact should be noted and the child ordered to report to the doctor's office for more careful observation. When a child is found to be affected with any form of physical defect, a complete physical examination should be made at the earliest possible opportunity.

Emergency Treatment.—Either the inspector or the nurse should treat all emergency cases as a matter of first aid and all such cases should thereafter be referred to the parents for reference to the family physician for future care. Failure to observe this rule may lead to unpleasant consequences for the physician and nurse on the ground of interference with the practice of a private physician or it may happen that the city or town authorities may be held responsible for what the parents consider to be improper practice.

EXAMINATION OF CHILDREN FOR PHYSICAL DEFECTS.

Extent of Physical Defects in Children of School Age.—It has been estimated by Dr. Thomas D. Wood, Professor of Physical Education of Columbia University, that there are approximately twenty million school children in the United States at the present time. He states that from 1½ to 2 per cent., or from 300,000 to 400,000, of these have organic heart disease; probably 5 per cent., or 1,000,000, have now or have had disease of the lungs; about 5 per cent., or 1,000,000, have spinal curvature, flat-feet or some other mild deformity serious enough to interfere with health; over 5 per cent., or 1,000,000, have defective hearing; about 25 per cent., or 5,000,000, have defective vision; about 25 per cent., or 5,000,000, are suffering from malnutrition; over 30 per cent., or 6,000,000, have enlarged tonsils, adenoids or enlarged cervical glands; from 50 per cent. to 95 per cent. have defective teeth.

Altogether, about 75 per cent., or 15,000,000 school children in this

country, are suffering from physical defects, almost all of which are preventable and which, to a certain extent, can be corrected.

Standards of Health in the Child of Rural and Urban Communities.—Wood has also made a study in eight States which shows that, in general, the occurrence of physical defects in country children is from 15 per cent. to 25 per cent. greater than among city children. It is probable that this sharp contrast did not exist several years ago, but at the present time systems of school medical inspection are so universal in cities that it would seem logical to assume that the prevalence of physical defects would be less noticeable in large centers of population than in places where little or no effort has been made to either prevent or correct them. The actual effect of city or rural life on the child can hardly be determined in a study of this kind. It would seem to show, however, that the general environment of the child, that is, whether it is rural or urban, has less importance than has been thought in the past, and that the predisposing causes of these physical defects or abnormalities are matters which concern the immediate surroundings or environment of the child and pertain more particularly to conditions in homes and in schools.

Frequency of Physical Examinations.—In a number of States laws have been passed making mandatory the physical examination of each school child each year. A careful survey of the administration of these laws fails to reveal that the results hoped for are being secured. These annual physical examinations are necessarily costly and the tendency therefore is to substitute a superficial inspection for what is supposed to be a careful physical examination. It is of far greater value to have a proper physical examination carried on two or three times during the school life of the child, supplemented by regular classroom inspections at frequent intervals, than to depend entirely upon an annual inspection, even though it may be called a physical examination. In Europe, generally, children are examined three times during their school life: First, on entrance to school, second, in the intermediate grades, and third, just before leaving school.

Studies of the occurrence of physical defects in school children show that, with the exception of defective vision, they are in inverse ratio to the age of the child. Physical examination, therefore, of children entering school for the first time is of the utmost importance. This should be thorough and complete and, wherever such course is possible, the child should have its clothes removed, at least as far as the waistline, for the purpose of this examination. In these cases it is also desirable that the follow-up work in the homes should be 100 per cent. efficient. If these children, on entering school, could be placed in proper physical condition, the later occurrence of a considerable proportion of physical defects might be discounted. Emergency cases or those occurring later in school life can usually be apprehended during the course of the regular classroom inspection.

Physical Defects.—Statistics regarding the prevalence of physical defects among school children are open to criticism because of the

lack of methods of standardization of the manner in which examinations are made and records kept. The following is offered as a guide:

Method of Physical Examination.—Each child must be carefully examined to determine the presence of any of the following defects:

1. *Defective Vision.*—The Snellen test-card should be used, with separate examination and record of visual acuity of each eye. A paper or card should be used to cover the eye not being tested.

2. *Defective Hearing.*—Either an acumeter or the watch or whispered voice test at a standard distance may be used.

3. *Defective Nasal Breathing.*—The nasal passages must be cleared and the passage of air through each nostril tested by pressure occlusion of the opposite nostril. Evidence of mouth breathing must be differentiated between (*a*) habit and (*b*) obstruction of the nasal passages.

4. *Hypertrophied Tonsils.*—Visual examination should be made with the use of a separate tongue depressor for each child.

5. *Defective Teeth.*—Visual examination should be made with reference to whether the primary or permanent teeth are affected and the extent of the defects.

6. *Defective Nutrition.*—It should be determined whether the condition is found alone or dependent upon other physical defects. The two following methods of determining the degree of undernourishment may be used as standards of measurement.

(*a*) Height and weight in relation to age, as shown by table on pages 712 and 713.

(*b*) The Dunfermline scale, as follows:

(1) "Excellent" means the nutrition of a healthy child of good social standing.

(2) Children whose nutrition falls just short of this standard are "good."

(3) Children "requiring supervision" are on the borderland of serious impairment.

(4) Children "requiring medical treatment" are those whose nutrition is seriously impaired.

7. *Cardiac Disease.*—In the case of boys, the examination for this condition should be made with a stethoscope over the bare skin. In the case of girls, the stethoscope must be used over the clothing unless the parent is present and consents to its removal or the written consent of the parent has been obtained for the removal of any part of the clothing. General objective symptoms should be noted.

8. *Pulmonary Disease.*—The lungs should be examined with a stethoscope. In the case of boys, the examination should be made over the bare skin. In the case of girls, the stethoscope must be used over the clothing unless the parent is present and consents to its removal or the written consent of the parent has been obtained for the removal of any part of the clothing. General objective symptoms should be noted and if any doubt exists as to the diagnosis the case should be referred for more extended diagnosis as hereinbefore described.

9. *Orthopedic Defects.*—The character of the defect should be noted.

10. *Nervous Diseases.*—The type of the nervous affection should be noted.

11. *Defective Mentality.*—No particular test need be given but when, in the opinion of the inspector, the mentality of the child is considered defective, a special note to that effect should be made to the teacher with the recommendation that the child be referred to the Inspector of Ungraded Classes of the Department of Education.

Follow-up Visits by Nurses.—Whenever a child is found to have a physical defect, a complete record of the physical examination should be made on a special form which is given to the nurse for follow-up work. This note should be made in duplicate, upon a form of record card which is to remain in school and be attached to the child's school record. This physical examination card should be transferred with the child and space should be provided for future examinations so that the complete history of the child may be available at any time.

If, at the end of three days, no notice has been received from the parent that the child is under medical care, and if the child shows no evidence of such care, the parent should be asked to call at the school and see the school doctor or nurse, who should explain to the parent the nature of the defect and the need of treatment.

These school consultations may be made most effective and should generally be held on Saturday mornings in the school buildings. By means of them the doctor and nurse will often be able to see from forty to fifty parents in three hours, the time that would be spent in making from ten to twelve home calls.

If the parent fails to come to the school within three days, and if it is evident that no satisfactory treatment has been obtained for the child within the following ten days, the nurse should visit the home and explain to the parent the environmental and personal changes in hygiene and individual treatment necessary to keep the child in good health. In this work the greatest tact is required. It is educational health work of the highest type. The public health nurse is not a person who cares for the sick; she is a teacher of health and the greater part of her endeavors should be concentrated upon instilling the principles of proper and wholesome living into the minds of the people with whom she comes into contact in her official capacity.

The first visit of the nurse to any home should be only to establish cordial relations and to assure the parents that her purpose is helpful. Later and repeated visits should be made to the extent necessary to see that the children are receiving the benefit of her instruction and receiving proper care. It is a legitimate part of the school nurse's work to take children to dispensaries for treatment if the parents are so occupied that they cannot spend the time for this purpose. In such instances, however, it is important that the nurse obtain from the parent a form of release of responsibility. This should be a card containing a statement from the parent in the form of a request to the nurse to take the child to a private physician or to a dispensary for treatment. This must be signed by one or both parents. Failure to

observe this simple requirement may lead to serious complications or even legal action.

Records.—The type of cards to be used in school medical inspection will necessarily vary with the extent of the work to be performed. The following are suggested as essential, even in simple systems:

1. Card notices to parents of the existence of contagious diseases or physical defects.

2. Circulars of instruction on the care of the health of children.

3. Health record of the child, to include:

(*a*) Data regarding date of birth and nationality of parents.

(*b*) Previous history, to include infectious diseases, date of vaccination and other health data.

(*c*) Record of all illnesses occurring while the child is in school.

(*d*) Record of all defects, together with measures taken to correct them.

4. Record of daily work performed by the inspector or nurse, to be forwarded to the central office for tabulation. Weekly reports may be used for this purpose.

RIGHT HEIGHT AND WEIGHT FOR BOYS.

(Tables prepared by Dr. Thomas D. Wood for the Child Health Organization.)

Height, in.	5 yrs.	6 yrs.	7 yrs.	8 yrs.	9 yrs.	10 yrs.	11 yrs.	12 yrs.	13 yrs.	14 yrs.	15 yrs.	16 yrs.	17 yrs.	18 yrs.
39	35													
40	37	38												
41	39	40												
42	41	42												
43	43	44	44											
44	45	45	46											
45	..	47	47	48										
46	..	49	50	50										
47	..	..	51	52	52									
48	..	..	53	54	55									
49	..	..	..	55	56	57								
50	..	..	..	58	59	59								
51	..	..	..	60	61	62	62							
52	..	..	..	..	64	65	65							
53	..	..	..	..	67	68	68	68						
54	..	..	..	..	70	71	71	72						
55	..	..	..	..	..	74	75	76	76					
56	..	..	..	..	..	77	79	79	80					
57	..	..	..	..	..	..	81	82	83	84				
58	..	..	..	..	..	..	84	85	87	88				
59	..	..	..	..	..	..	..	88	89	91	92			
60	..	..	..	..	..	..	..	90	92	94	95			
61	..	..	..	..	..	..	..	..	97	99	100	101		
62	..	..	..	..	..	..	..	..	100	102	104	105		
63	..	..	..	..	..	..	..	..	104	106	108	109	110	
64	..	..	..	..	..	..	..	..	..	112	113	115	117	120
65	..	..	..	..	..	..	..	..	..	118	119	121	122	123
66	..	..	..	..	..	..	..	..	..	..	123	124	125	127
67	..	..	..	..	..	..	..	..	..	..	125	126	127	131
68	..	..	..	..	..	..	..	..	..	..	130	131	133	136
69	..	..	..	..	..	..	..	..	..	..	..	134	136	139
70	..	..	..	..	..	..	..	..	..	..	..	136	140	143
71	..	..	..	..	..	..	..	..	..	..	..	..	142	145

ABOUT WHAT A BOY SHOULD GAIN EACH MONTH.

Age.	Ounces.
5 to 8 years	6
8 to 12 "	8
12 to 16 "	16
16 to 18 "	8

RIGHT HEIGHT AND WEIGHT FOR GIRLS.

Height, in.	5 yrs.	6 yrs.	7 yrs.	8 yrs.	9 yrs.	10 yrs.	11 yrs.	12 yrs.	13 yrs.	14 yrs.	15 yrs.	16 yrs.	17 yrs.	18 yrs.
39	34													
40	35	37												
41	39	39												
42	41	42	42											
43	43	44	44											
44	45	46	46											
45	..	47	47	47										
46	..	48	49	50										
47	..	..	50	51	53									
48	..	..	52	53	54									
49	..	..	..	55	56	57								
50	..	..	..	57	59	60								
51	..	..	..	..	61	62	63							
52	..	..	..	..	65	66	67							
53	..	..	..	..	..	68	68	69						
54	..	..	..	..	..	70	71	71						
55	..	..	..	..	..	..	72	73	74					
56	..	..	..	..	..	..	76	77	77	79				
57	..	..	..	..	..	..	..	79	82	85				
58	..	..	..	..	..	..	..	85	88	93	96			
59	..	..	..	..	..	..	..	..	92	95	100	105		
60	..	..	..	..	..	..	..	..	97	99	103	107	109	
61	..	..	..	..	..	..	..	..	99	102	105	109	111	
62	..	..	..	..	..	..	..	..	..	105	107	111	113	116
63	..	..	..	..	..	..	..	..	..	107	110	113	115	117
64	..	..	..	..	..	..	..	..	..	..	114	117	119	121
65	..	..	..	..	..	..	..	..	..	..	..	121	123	125

ABOUT WHAT A GIRL SHOULD GAIN EACH MONTH.

Age.	Ounces.
5 to 8 years	6
8 to 11 "	8
11 to 14 "	12
14 to 16 "	8
16 to 18 "	4

5. A tabulation sheet, to be kept in each school, showing the number of physical examinations made and the number and character of physical defects found, together with the results of treatment obtained.

Other forms of reports will naturally suggest themselves and the standard types used in Philadelphia and New York City are recommended.

Hygiene of the Child.—The relation of height and weight to the age of the child may be taken as the best index we have of its growth and development. The accompanying table, prepared by the Child Health Organization of New York City, may be considered a standard:

In considering this table, allowance must be made for racial characteristics. Certain race groups, notably the Italians, are naturally small, while certain other Northern races, such as the Norwegian, often exceed the average for American children.

The general hygiene of the child includes proper distribution of its hours of study, sleep and play, its bathing, clothing, diet, home surroundings and habits, with individual adjustment in special cases.

Study.—Our modern school curricula are overburdened and proper study time is rarely allowed within school hours. Children from five to seven years of age usually spend three hours a day in school and should have no home study. Children from seven to ten years of age may have five hours of school work with one hour of home study. Children from ten to twelve years old may have five hours of school work and one and a half hours of home study, while from twelve to fourteen years of age, five hours of school work with two hours of home study may be allowed. This home work should be done in the late afternoon or early evening, leaving the daylight hours for outdoor play. If artificial light must be used, it should preferably be a well trimmed oil lamp or low-hung gas or electric burner with the light directly over the left shoulder or placed on a table at the left side. Such simple methods will often prevent eyestrain and obviate headache. The following table is suggested as a standard:

Age, years.	School hours.	Hours for home study,	Hours for meals and play.	Hours for sleep.	Bedtime.
5 to 7	3	none	10	11	7.30
7 to 10	5	1	8	10½	8.00
10 to 12	5	1½	8	9½	9.00
12 to 14	5	2	8	9	10.00

Standards of bathing, clothing and diet should be those recommended by authorities on pediatrics. It must be remembered that children learn more readily by the type of instruction which permits them to understand and act directly upon suggestions rather than by abstract study of the questions of hygiene itself. A successful procedure has been to outline for children of different ages a time table covering their waking hours. These should start somewhat as follows:

7 A.M. Throw back the bedclothes; rise; go to the open window and take ten deep breaths; close window; strip bed for airing and take sponge bath over the entire body, with tepid or cold water.

7.15. Dress.

7.30. Breakfast.

8.00
to
8.30. Play.

8.30. Start for school, etc.

Such programs may be varied to suit individual needs but should always be simple, direct and concrete.

Hygiene of the Home.—The sanitary and hygienic conditions of the child's environment are factors of importance in determining the

occurrence of physical defects. They may also be reflected in the lowered vitality of the child which predisposes toward the occurrence of certain types of contagious diseases. For these reasons the home surroundings of children should receive particular attention.

The minimum air space which should be allowed for living apartments of any family are six hundred cubic feet for each adult and three hundred cubic feet for each child. Adequate ventilation, proper disposal of refuse, prevention of flies and general cleanliness are of the utmost importance, particularly with reference to the health of young children.

In any community, the school inspector and nurse should be cognizant of the laws relating to building and housing conditions and should report all infractions of such laws to the proper officials. The maintenance of the home in a decent and cleanly condition may become part of the work of the school nurse. It is her duty to so instruct the family that the children may be enabled to live in the best hygienic conditions, possible, considering the primary limitations of the home.

Contrary to the general belief, it can often be shown that small shacks or shanties in country places are less hygienic and sanitary than tenements in a large city. Such living conditions undoubtedly have marked effect upon the health of the children who dwell therein. Home hygiene, which is closely related to the personal hygiene of the child, merits the serious attention of the school nurse, with reference to the prevention of the various diseases and defects of childhood.

School Hygiene.—Practically everything that has to do with the construction of the schoolhouse and its furnishings and maintenance may affect in some degree the health of the child. School hygiene, in itself, therefore, must take up questions relative to everything that pertains to the location, furnishings and care of the school building.

Location of School Buildings.—In cities, the general direction of the streets available for the location of school buildings may determine their orientation. There is, however, always a certain latitude in this regard, with particular reference to the location of the classrooms. Even on the most crowded streets it is usually within the power of the architect to determine whether the classrooms generally shall open upon the street or upon courts. Questions of proper light as well as exclusion of all unnecessary noise and street dust must be considered as they relate to the welfare of the child. In the country, such limitations ordinarily do not exist and it is generally possible to place the school buildings in any desirable position or location. In the country districts, however, it is necessary to consider the question of drainage and the proper location of the outhouses. For this reason, the site of the schoolhouse should, if possible, be on high ground with good drainage. The water supply should be piped from a distance, if possible, but if it must be drawn from a nearby source, care should be taken to see that the outhouses are not placed in such a position that the sewage may be drained into any part of the water supply. All other contamination of the water supply should be guarded against.

If possible, schoolhouses should be built so that the classrooms face east or west. Classrooms facing east are preferable because they receive the early morning sunshine, which rarely enters the room later than ten o'clock. This affords the early flooding of the rooms with sunlight, with windows open, and disposes of the annoyance of crosslights or bright sunshine during the remainder of the day. For the same reason, classrooms with western exposure are proper. Here the sunlight enters late in the day, but there are no annoying crosslights during the study hours. Rooms with southern exposure should never be used. Here the sunlight comes into the room during the greater part of the day and the light is difficult to control. Rooms with northern exposure have practically no sunlight and are undesirable for that reason.

Size of Classrooms.—The classroom where the child spends at least four-fifths of his time while in school has a most intimate relation to health. Generally speaking, classrooms in the United States are too small for the number of children who are placed therein. The standard and ideal classroom depends upon several factors:

Length.—Length of a classroom is determined by the distance that the ordinary speaking voice of the teacher will carry so that the child in the last row may hear distinctly, also by the distance at which the child can read the blackboard without straining his eyesight. Numerous studies have shown that the distance over which the ordinary teacher's voice will carry well is twenty-nine feet. Allowing for a three-foot aisle at the end of the room, the standard length of the classroom has been placed at thirty-two feet.

Width.—Here the points to be considered are whether or not the classroom is lighted from one side only and the provision of abundant light. In unilateral lighting, the width of any classroom should not be greater than twice the height of the top of the windows from the floor, provided the total glass surface is not less than one-sixth of the floor surface. The width of the room, therefore, will depend to a great extent upon its height. Windows should be so placed that they come within six inches of the ceiling and their lower edge should be four feet from the floor. They should generally be placed so that the light comes on the left side of the child and the windows should be toward the back rather than toward the front of the classroom. Under such circumstances the rays of light coming in the windows of this size and placement will carry into the room a distance equal to double the height from the top of the window to the floor. In considering the height of the ideal classroom, we will find that it is placed at twelve and a half feet. The height of the windows from the floor, therefore, will be twelve feet and the rays of light will carry twice that distance, or twenty-four feet, giving us the latter as the width of the classroom.

Height.—It has been found that a classroom thirty-two feet long and twenty-four feet wide cannot have a ceiling higher than from twelve and a half to thirteen feet without seriously interfering with the type of heating and ventilation which is essential. Most mechanical

ventilating systems work best with a ceiling of such height and as any higher ceiling allows warm air to remain undisturbed just below the ceiling, that much space is wasted. The standard height, therefore, may be placed as twelve and a half feet.

Lighting.—Mention has already been made of the size and location of the windows. The light should always fall from behind and always above the line of vision of the children. If the light is intense, dark green shades should be used. With east or west lighting, tan shades are sufficient.

Walls.—The walls of a classroom should be painted a neutral color, preferably soft tan or green. A much darker shade of the same color should reach from the floor to a height of at least six feet. This will prevent undue reflection of light in the line of vision of the children.

Blackboards.—Slate is generally considered the best material for blackboards as it does not glisten or reflect light. They may, however, be made of cement, paper or fiber. In the primary grades, the lower edge of the blackboard should be within two feet of the floor. In the elementary grades they should be from thirty to thirty-five inches from the floor. In order that there may be no eyestrain on the part of the children, the blackboards should be kept in a cleanly condition and washed at least once a day. Only white crayon should be used for the general routine of school work. Erasers should be cleaned thoroughly each day, preferably with a vacuum cleaner. When this cannot be done, the erasers should be taken outdoors and thoroughly cleaned by being beaten or brushed with a large floor brush.

School Books.—School books should never be printed on glazed paper. The length of the line should not exceed three and a half inches and the distance from line to line should never be less than one-eighth inch. No type smaller than long primer should be used for general reading. Small pica is preferable. For young children pica type should be used. In the kindergarten classes or the first grade, primer type is preferable.

Desks and Chairs.—The most important factors in the correct seating of children are (1) that the seats be of proper height and size for the pupils, (2) that the desks be placed at such a slant that the child will not strain either his body or his eyesight in assuming a correct position for easy desk work, and (3) that the chairs be so constructed that the backs afford natural support for the backs of the children in any position that may be required in the ordinary routine of class work. There are a large number of desks and chairs on the market which purpose to fulfil these requirements. They are of many types, some with both desk and chair movable, some with only the chair movable, some with desk and chair attached, and practically all at the present time adjustable to various sitting positions. Movable chairs have a possible advantage in open air classes in that they may be pushed aside and cots put in their places. They are objected to for regular classroom work, however, mainly because of fire hazards as it is felt that it is not possible to get children from school buildings as quickly with movable chairs as with those attached to the floor.

When proper school furniture has been installed, it is essential to see that it is properly used. Desks and chairs should be adjusted each term to fit the pupils who are to occupy them. A practical rule for the height of the desk and chair consists in having the seat of the chair at such height that the child's feet rest evenly and firmly on the floor. Desks should extend two inches over the edge of the seat and be sufficiently high to allow the child's forearm to rest upon the lid without stooping of the shoulders. An easy way of computing these heights is to have the children, at the beginning of each term, stand with the back to the blackboard and have the teacher mark the exact height. The desks should then be adjusted so that the top is three-sevenths the height of the child, while the seat is two-sevenths of the child's height. Desks should preferably be individual and be placed so that there is an aisle space of at least two feet between the rows. The question of adjustable desk tops which may be slanted so that books may be held upon them for easy reading is one that applies to older children mainly. It has been mentioned by teachers that it is difficult to teach children to write on such a slanting surface but desks are now made so that their tops are adjustable and may be slanted for reading purposes and placed with only a slight degree of slant for writing, as required. Proper maintenance of seats and desks in the correct condition is of the greatest importance because of its bearing upon the acquisition of postural defects in children, particularly lateral curvatures of the spine. Such defects are of common occurrence when children are seated at improperly adjusted desks.

Ventilation.—During the past few years the question of ventilation of dwelling houses and school rooms has received an unusual amount of attention and many points in regard to it are still considered debatable. The following factors, however, may be considered as having been determined:

Air which is brought into buildings where persons live must be clean and of proper temperature, with the humidity in proper proportion to the temperature, and should be subject to a constant current of motion. Ordinary standards for classrooms have been placed at three hundred cubic feet of air space for each child. In England the required air space for each child is less than one hundred cubic feet. The standards of the Department of Education of New York City allow two hundred and fifty cubic feet. It may be assumed, however, that nothing less than three hundred cubic feet per child can be allowed if adequate standards of ventilation are to be maintained. Anything less does not permit of the required air changes without creating a serious draught. With three hundred cubic feet of air space for each child, and assuming that each child of elementary school age would require at least three thousand cubic feet of air per hour, it is seen that this would entail a complete change of air in the classroom once every six minutes. It is possible, however, to effect such change by the utilization of both natural and artificial methods of ventilation. In classrooms where there are few windows or where the latter open upon

a small or restricted court, it is probable that some type of mechanical ventilation will be essential. This is also true of wholly enclosed rooms, such as assembly rooms in the center of large schools.

It is becoming more and more apparent that, except for these limitations, artificial systems of ventilation are not required in the modern school building and that natural ventilation by means of open windows, with proper window deflectors, may be accepted as the type of ventilation which is most conducive to the health of the pupils.

It has been found that a temperature of sixty-eight degrees seems to be most conducive to proper classroom work in this country. The European standards are much lower, fifty degrees often being accepted as a proper temperature for classrooms in European countries. With a temperature of sixty-eight degrees Fahrenheit, a 40 per cent. humidity should be allowed in cold weather and 50 per cent. humidity in ordinary winter weather.

Mechanical systems of ventilation depend upon the propulsion of air through ducts into the room and the extraction of the foul air through other ducts. Generally, the inlet ducts for fresh air are placed about eight feet above the floor and the outlet ducts are placed on the same side, with the openings near the floor. This fresh air, which is forced into the room, may be heated, washed, cleansed or filtered by means of special appliances before it reaches the classroom.

The inadequacy of mechanical systems of ventilation has been shown by the difficulty of their proper maintenance. The care of such systems is usually placed with the janitor of the school and their efficiency depends in large degree upon his interest in this direction. Mechanical engineers claim that the installation and maintenance of such systems are problems attended with little difficulty but the practical working out of such systems has not been wholly satisfactory. For this reason, as well as because it has been evident that the relation of ventilation to the health of school children is a subject of considerable importance, studies have been made from time to time with the object of determining the proper type of ventilation for classrooms. Taking the respiratory diseases as an index of the effect of ventilation upon the health of children, the Bureau of Child Hygiene of the Department of Health of New York City, in coöperation with the New York State Commission on Ventilation, conducted in 1915 and 1916 a study among 5533 pupils in seventy-six classrooms in twelve schools in New York City.

These classrooms were operated under three different types of ventilation: Type A was made up of classrooms ventilated by mechanical systems of ventilation and kept at a temperature of about 68° F. In this type of classroom, the windows were kept closed. Type B classrooms were kept at a temperature of about 68° F. and ventilated wholly by open windows, no mechanical system being used. Type C classrooms were kept at or about 50° F., ventilation being wholly by open windows, no mechanical system being used.

It was found in this study that:

In the closed window, mechanically ventilated type of classroom, kept at a temperature of about 68° F., the rate of absence from respiratory diseases was 32 per cent. higher than in the open window, naturally ventilated type of classroom kept at the same temperature and about 40 per cent. higher than in the open window, naturally ventilated type of classroom kept at a temperature of about 50° F.

In the closed window, mechanically ventilated type of classroom, kept at a temperature of about 68° F., the rate of respiratory disease occurring among pupils in attendance was 98 per cent. higher than in the open window, naturally ventilated type of classroom kept at the same temperature and about 70 per cent. higher than in the open window, naturally ventilated type of classroom kept at a temperature of about 50° F.

In this investigation it was also found that the relative humidity of classrooms, whether ventilated by natural or mechanical means, was not a causative factor in the occurrence of respiratory diseases among school children; and, further, that the occurrence of respiratory diseases among school children was not influenced by sex.

The open window type of classroom mentioned in this investigation was the ordinary schoolroom with windows open from the bottom about six to eight inches. In some, window boards were used. In others, ordinary wood or glass window deflectors, placed at an angle from the window sill served the purpose. In this way no direct drafts were created.

In all schools the classrooms should have the windows thrown wide open for a period of at least one hour each morning, lasting until within a half hour of the opening of school. At the end of each class period the windows should be opened for at least two minutes while the children are engaged in setting-up or running exercises. In country schools, where the heating of the schoolroom is a distinct problem and where ordinarily a stove is used for the purpose, the ventilation is apt to be a matter of great difficulty. Possibly the simplest method of ventilating a country schoolroom without draughts is to cut out the whole or part of the upper pane of glass of alternate windows and have the window frame covered with a layer of ordinary unbleached muslin. This may be tacked into place and changed and washed when it becomes soiled. The air filtering in through this cloth screen is not only cleansed but it does not create any strong current. It has the further advantage of subduing the light from the upper panes of the window.

Cloakrooms. — It is the tendency in schools generally to place the cloakrooms in dark, unventilated closets. The main features to be remembered are that the hygienic type of cloakroom must be well ventilated and that it must consist either of lockers or of hooks, so spaced that the clothes of one child will not come into contact with that of another. The individual locker system is undoubtedly the best but it is also expensive. Much the same result may be obtained by the use of the individual hooks properly spaced. For safety in case

of fire, it is better to have individual cloakrooms connected with each classroom. These cloakrooms or lockers may be so situated that an air exit may be placed in them and, with wire screens for doors, they may be sufficiently ventilated from the classroom. Care should be taken, however, to see that such lockers open either directly into the classroom or, if it is a separate closet, it must have a door of entry from the classroom and another which opens into the outside corridor, otherwise it may become a source of actual menace in case of fire.

Toilets. — The toilet facilities in city schools are usually subject to the requirements of the local sanitary regulations. There should be provided, however, at least one toilet for every fifty children and an additional urinal for every fifty boys. Toilets for the sexes should be kept quite separate and distinct. The U-shaped toilet seat is advised, in order to prevent infection. In country schools the ordinary outhouse or privy must be placed in such a position that its drainage will not contaminate the water supply. Open privy vaults should not be allowed in any case.

There are many types of privy vaults adaptable to country homes or schools which can be built at comparatively little expense. Details of such vaults may be obtained from the United States Public Health Service. In addition, there are on the market many types of chemical closets which have been found to be effective. These closets have the appearance of an indoor closet. They are connected with a drainage tank which receives the excreta, which is kept in a fluid state by means of the action of certain chemicals. At intervals these tanks have to be cleaned and the deposit taken away, but this is necessary only at infrequent intervals, and, in general, these closets are not offensive, are easily kept in order and entirely practical.

Washing and Drinking Facilities. — The use of the common towel should be prohibited in all schools. When paper towels are not available, either because of the cost or the difficulty in obtaining them, each child should be advised to bring a clean towel from home each week, returning it to be laundered at the end of the week. Provision should be made in every school for adequate facilities so that the children may wash their hands after each visit to the toilet. Common drinking cups should not be allowed in any event, but care must be taken in the installation of drinking fountains to see that only such types are employed where the child's mouth cannot rest upon the nozzle during the act of drinking. Generally speaking the types of drinking fountains which shoot a jet of water from a side opening or those where the convergence of several streams of water make a central fountain point are preferable. If cost is a consideration the ordinary faucets in any school building may be made into acceptable drinking fountains by having them turned upside down or extension pipes may be run from the faucets and regular nozzles attached. In country schools the question of drinking facilities is much more difficult to solve. Various types of easily made drinking facilities may be installed, as by placing a hogshead on a high level and having pipes reach down,

ending in a U-shaped nozzle at the end. This, with a convenient stopcock to regulate the flow of water, can be made an acceptable drinking fountain, as far as the mechanical side of the matter is concerned. The difficulty lies in keeping the tank clean. For that reason individual paper cups should be advised, to be used with the ordinary water supply.

Maintenance of School Buildings.—All classrooms and hallways should be cleaned thoroughly each day. Dry sweeping and dusting should not be allowed. Various types of oil dressings, which are thrown into the room in the form of a spray, which settles on the floor and desks, may be recommended. After use of these dressings, it is simply necessary to wipe up the floors with a soft cloth, and mopping or sweeping is not essential. Vacuum cleaners should be used, of course, whenever possible. Walls and desks should be wiped off with a damp cloth at least once a week. In the case of infectious diseases occurring in any classroom, the use of disinfectants and various methods of fumigation are not advised. Windows of such classrooms should be kept open for at least twelve hours and the walls, furniture and floors thoroughly scrubbed with soap and water.

Special Classes.—In recognition of various types of physical infirmities or defects, practically all city schools have now segregated certain types of children into special classes. Thus we have open-air classes for anemic and tuberculous children, classes for crippled children, classes for sight conservation, classes for the blind and classes for children with cardiac disease. The main features of these classes are that they should be easily accessible, particularly in the case of the cardiac classes, and care should be taken to see that these children do not have to climb stairs. In classes for crippled children, a special type of desk and chair is necessary. In open-air classes a standard equipment may be used. Here it is advised that the parka, thick bloomers or trousers and boots, mittens and hood be used generally, instead of the sleeping bag, on account of the greater use of movement. In all of these classes fresh air is a matter of the first importance and adequate ventilation or outdoor life should be maintained at all times. Food is important, also, and there should be provided a lunch of milk or cocoa and bread and butter at eleven o'clock, a hot lunch at twelve-thirty including soup and cocoa, with sandwich and hot meat and vegetables, and another meal at four o'clock, consisting of milk or cocoa and crackers or bread and butter. Special methods of training these children need not be considered as relating to their health except that such children should be under close supervision, with particular reference to the care of their particular defect or abnormality. For this purpose, it is usually better, as an administrative measure, to assign certain doctors and nurses to the exclusive control of these special classes. It has been found that greater interest is aroused and more effective work accomplished when this is done.

CHAPTER XXVI.

SOCIOLOGIC AND ECONOMIC ASPECTS OF DISEASE.

By CHARLES F. BOLDUAN, M.D.

The student of medical history cannot fail to be impressed by the fact that until recently the practice of medicine has been confined to the art of healing the sick. It has dealt almost entirely with the individual and has considered disease purely from an individualistic standpoint. A different viewpoint was gradually introduced, the result of the development of what was called "public medicine," in Italy during the Renaissance. This taught the value of quarantine, isolation and other preventive measures, and gradually led to the establishment of our present systems of public health administration. In the latter half of the nineteenth century important developments in the natural sciences, and especially the epoch-making discoveries of Pasteur, Koch and their contemporaries, led to a reconsideration and reconstruction of the current views regarding the nature and cause of disease and to the adoption of concepts based largely on laboratory investigations. It would be foolish to deny the debt which medical science owes to introduction of these laboratory concepts. Nevertheless, we should not fail to recognize the fact that a too constant reliance on laboratory methods alone has proved distinctly detrimental and that it is time to adopt a broader viewpoint in order to promote public health.

Under the spell of the wonderful discoveries in bacteriology of the eighties and nineties of the last century there crept into the writings of most medical authors statements concerning the etiology of the infectious diseases, which in the light of our present knowledge must now be considered as entirely inadequate. Almost without exception these writers speak of the tubercle bacillus as being the cause of tuberculosis; the pneumococcus as the cause of pneumonia; the staphylococcus as the cause of boils, furuncles and abscesses; the gonococcus as the cause of gonorrhea, etc. Only in recent years do we hear a protest raised at this unwarranted use of the expression "the cause." In an interesting essay published several years ago von Hansemann points out that it is extremely rare to have relations so simple that any one particular microörganism can be regarded as the cause of some one disease. Almost invariably it is but one of the causes, an essential one to be sure, nevertheless only one of several. For the student of public health this distinction is of the greatest importance, and it may be well, therefore, to give the matter further consideration.

Let us take, for example, pulmonary tuberculosis. Practically all the text-books speak of this as caused by the tubercle bacillus, and that this is one of the essential causes is acknowledged. Nevertheless, we know, from autopsy studies, that practically all adult human bodies show evidences of tuberculosis infection. Moreover, we are all frequently exposed to the inhalation of tubercle bacilli, yet only a relatively small proportion of us develop pulmonary tuberculosis. Evidently, then, the presence of the tubercle bacillus is not synonymous with tuberculosis. To say that the body resistance constitutes the other necessary factor is to be satisfied with a mere label, whose acceptance as an explanation shuts off further inquiry into the unknown.

Inasmuch as many of our public health problems have failed of solution when attacked from the standpoint of the germ as the cause, *e. g.*, pneumonia, is it not worth trying to discover all the causative factors in any given disease, to ascertain which of these are essential factors, and, this much determined, how any one essential factor may be successfully attacked so that the occurrence of the disease may be prevented.

Among the causative factors which almost all writers either pass over very lightly or ignore altogether there are none of greater importance to the health official than those dealing with the social and economical conditions pertaining to the disease. This point is clearly presented by Grotjahn, who speaks of a "social pathology" of disease. In recent years this aspect of disease is beginning to receive some consideration. Thus in the oft quoted report of the United States Children's Bureau regarding infant mortality in Johnstown, Pa., we find tables showing that the infant mortality-rate varies with the family income—the lower the income the higher the infant death-rate. In the case of tuberculosis it has often been pointed out that the frequency of the disease increases directly with the number of persons per room.

The high infant death-rate among illegitimate children has long been known. The high prevalence of venereal disease in seaport towns is also recognized.

It may be helpful to classify the ways in which social and economical conditions are causally related to disease. Following is the classification suggested by Grotjahn:

1. The social and economic conditions create or favor the disposition to the disease.

2. The social and economic conditions bring with them the conditions which are necessary for the disease to develop.

3. The social and economic conditions constitute the means of transmission of the disease.

4. The social and economic conditions influence the course of the disease.

Of perhaps equal importance to the health officer, and certainly to the community, is the influence exerted on the community's social and economical structure by disease. It is clear that from this standpoint the significance of disease depends primarily on its prevalence. No

matter how dangerous to the individual a given disease may be its significance to the community is slight if it is infrequently met with. More than this, however, we must take into consideration the character of the disease, *i. e.*, to learn in what form the disease most frequently appears. The classic text-book type of the disease is not always the predominant type.

Besides the actual prevalence of a disease, society is much concerned as to the age of the persons chiefly attacked. Assuming three diseases equally prevalent, one affecting chiefly infants, another chiefly young and middle-aged adults, and the last, chiefly those in advanced life, one would have no question as to which was most important from the social standpoint.

From the social standpoint the outcome of a disease is of great importance to the community. The various outcomes may be enumerated as follows: death, complete recovery, physically handicapped, chronic invalidism, predisposition to other diseases, transmissible impairment.

When one considers the many complex interrelations between disease on the one hand and social and economic conditions on the other, is it not likely that a more careful study of these relations—in other words, of the social pathology of disease—will help us reduce the prevalence of many diseases which up till now have baffled all our efforts? Has our failure perhaps been due in some instances to a too restricted point of view, and have we been treating symptoms rather than causes? In this connection one may call attention to the statement made by Gorgas in commenting on the influence of overcrowding on the spread of disease in the Panama Canal Zone. Gorgas gave it as his opinion that the introduction of the single tax, by promoting a greater use of land for building purposes, would constitute a public health benefit of incalculable value. This is an illustration of how fundamental a viewpoint of health problems is taken by a successful health administrator.

In order to give the reader some idea of the nature of the studies made in the field of social pathology, and especially to serve as a typical picture of the newer viewpoints thus revealed, I have collected in the following pages some of the more important social data relating to tuberculosis and to infant mortality. Much of the material is taken from Grotjahn's[1] excellent work on *Social Pathology*, to which the student is referred for further details.

TUBERCULOSIS.

Tuberculosis is well termed a disease of the masses. The fact already alluded to that most human adults are found at autopsy to show evidences of tuberculous infection indicates that something more than the mere presence of the tubercle bacillus is involved as a causative

[1] Soziale Pathologie, 2d edition, August Hirschwald, Berlin, 1915.

factor. Inasmuch as the importance of a disease, from the community's standpoint, is often directly proportional to its frequency, it may be pointed out that in many communities tuberculosis is responsible for more deaths than any other individual cause of death. Moreover, it affects persons in the best period of life, young and middle-aged adults. This is well shown by the following typical table giving the age distribution of deaths from tuberculosis. The conditions here shown for New York City are practically the same everywhere:

DEATHS FROM PULMONARY TUBERCULOSIS, NEW YORK CITY, 1916.

	Male.	Female.
Under 15 years	36	50 per 100,000
15 to 24 "	121	118 "
25 to 44 "	289	158 "
45 years and over	411	124 "

It is also to be noted that males are more frequently affected than females, a fact which has generally been explained by the larger proportion of males in industrial life. In recent years the proportion of deaths of females from tuberculosis is said to be rising in some of the English and German industrial centers, due to the increasing proportion of women entering industrial life.

It has long been recognized that the incidence of tuberculosis is closely related to the prevailing occupations. It is high among cutlery-grinders, marble- and stone-cutters, cigar- and tobacco-workers, compositors, printers and pressmen and hat- and cap-makers. On the other hand the prevalence of tuberculosis is low among engineers and surveyors, teachers, lawyers, soldiers and sailors, steam-railway employees, farmers, planters and coal-miners.

Dusty trades are closely related to the prevalence of tuberculosis, but the character of the dust appears to play a highly important role. Among stone-workers it is a matter of common observation that limestone dust is but little harmful; flint and quartz dusts, on the other hand, are exceedingly dangerous. Coal dust appears to be quite harmless, so far as tuberculosis is concerned, for coal-miners have a low tuberculosis rate. Millers formerly had high tuberculosis rates, apparently due to stone dust from the mill-stones. Since the introduction of modern steel-roller mills the tuberculosis rate is said to have markedly decreased.

Writers on tuberculosis make frequent reference to the relation between tuberculosis prevalence and housing conditions. They point to the frequency with which the consumptives are found living in poorly ventilated, dark, mean tenement houses, and this cannot be disputed. It must not be forgotten, however, that this in itself does not prove causal relationship, or, even admitting such relationship, in what proportion of cases the disease is the cause and in what effect. It is well known that tuberculosis makes such a drain on the family income that these families are found moving from one house to another, and almost always to cheaper and poorer quarters. However, there

can be no question that improved housing constitutes one of the pressing needs in the campaign against tuberculosis.

The number of rooms occupied by the consumptive and his family is important, for unless a separate sleeping room can be provided for the patient the spread of infection cannot be avoided.

It must not be supposed that wretched housing conditions, together with high tuberculosis rates, are found only in city slums. The filthy, overcrowded farmhouse is not at all uncommon, and undoubtedly plays an important part in the dissemination of tuberculosis among the rural population.

Tuberculosis is very directly related to economic conditions. Its prevalence decreases as the economic conditions improve. This is well shown by the following compilation concerning tuberculosis in Hamburg, 1901–1905. This shows the deaths from tuberculosis per 100,000 population, in five different groups arranged according to taxable income:

A taxable income of	Number of persons.	Death-rate, tuberculosis, per 100,000.
900 to 1200 marks	71,526	482
" 2000 "	48,855	447
" 3500 "	21,397	274
" 5000 "	8,342	252
over 5000 "	14,323	120

From the social standpoint an important consideration is the fact that not only does tuberculosis cause a very large proportion of deaths but also causes a large amount of physical impairment and invalidism. What this amounts to in years may be gauged from the following table compiled by Koelsch from German sickness insurance statistics. In a certain nine-year period 161,409 men under sixty years of age were granted pensions by sick benefit funds. With the aid of a life table to show what the normal expectancy of life was at the different age periods, it was found that this precocious invalidism had caused a loss of 1,842,413 years, an average of 11.4 years for each pensioner. The form of the calculation was as follows:

38	pensioners	were	only	20	years	old.	Loss	amounted	to 1,280 working years.
1097	"	"		21	"		"	"	36,062 " "
1910	"	"		30	"		"	"	48,602 " "

Inasmuch as tuberculosis was the cause of invalidism in 13.3 per cent. of all the cases the author concludes that tuberculosis in these nine years caused a loss of 239,210 working years.

In dealing with the care of tuberculosis patients the sociopathological viewpoint insists that the various measures taken by the community be economically sound. Thus in caring for advanced indigent cases of the disease the provision of expensive public hospitals, where the life of the patients may be prolonged as far as possible is generally condemned as being economically unsound. Unless such a patient can be kept in a condition where he will be at least self-supporting it is a mistake to seek to prolong his life. He should, of course, be

made physically comfortable, but aside from this, so far as the community is concerned, the earlier the fatal ending the better.

Entirely in harmony with these principles is the attempt in various quarters to provide suitable remunerative occupations for patients discharged from tuberculosis sanatoria. The excellent work done in New York by the Committee on the Care of the Jewish Tuberculous and in Edinburgh by Sir R. W. Philip shows what can be done in this direction.

INFANT MORTALITY.

The number of infants born who fail to survive the first year of life is still very great. In the United States, in 1918, from about 80 to 150 infants out of every thousand infants born alive died during their first year. In some parts of Russia one out of every three infants born succumbs during the first year. In New Zealand, on the other hand, the rate averages about 50 per 1000. In Calcutta, in 1915, several parts of the city had rates approaching 500 per 1000 births.

Examining into the causes of high infant mortality, one is impressed at once by the remarkable difference between the mortality of breast-fed infants and those brought up on the bottle. This is well illustrated by the following table:

INFANT MORTALITY—ACCORDING TO TYPE OF FEEDING.

Age of baby.	Babies alive at indicated age.	Breast-fed exclusively.			Mixed food, breast and other.			Artificial food, no breast milk.		
		Total.	Deaths in first year.		Total.	Deaths in first year.		Total.	Deaths in first year.	
			No.	Rate per 1000 alive at specified age.		No.	Rate per 1000 alive at specified age.		No.	Rate per 1000 alive at specified age.
End of 3 mos.	1355	987	46	46.6	175	10	57.1	193	32	165.8
End of 6 mos.	1313	616	18	29.2	447	10	22.4	250	18	72.0
End of 9 mos.	1282	220	3	13.6	709	8	11.3	353	4	11.3

The question at once arises, are the mothers physiologically unfitted to nurse their infants in so large a proportion of cases, or are there other reasons why they do not do so? In answer to this we may cite the figures compiled by Schwarz, director of the pediatric department of Dr. Hill's maternity clinic in New York. Schwarz found that of 1500 mothers only four were physiologically unfitted to nurse their babies. All the rest could do so when encouraged by proper care at and after confinement. Of these 1500 mothers, 96.9 per cent. nursed one month, 89.1 per cent. three months and 77 per cent. six months.

Why, then, do not more mothers nurse their babies? A partial answer is supplied by the following table from Johnstown, Pa.:

	Infants breast fed.						Infants only artificially fed.	
	Wholly.		Partially.		Together.			
	Infants.	Per cent.	Infants.	Per cent.	Infants.	Per cent.	Infants.	Per cent.
Mother gainfully employed, 678	155	22.86	94	13.86	249	36.73	429	63.27
Mother not gainfully employed, 5915	3046	51.50	845	14.29	3891	65.78	2024	34.22

This table also furnishes us with an explanation of the fact that infant mortality-rates are usually high in industrial centers employing large numbers of women. Moreover, the steady rise in the proportion of women engaged in industrial pursuits makes it extremely important to take cognizance of the relations here pointed out.

It has long been recognized that the infant mortality-rate is closely related to hot weather. This is well shown by the following tables one from the U. S. Registration Area and the other from Germany. It will be noticed that in both the infant mortality-rate rises markedly during the months of July, August and September:

Months.	Deaths. Diarrhea and enteritis under 2, U. S. Registration Area, 1918.	Deaths. All causes, under 1, German cities, 1911.
January	1775	24,384
February	1712	23,407
March	2040	24,459
April	2192	23,291
May	2712	22,709
June	4027	23,159
July	6811	38,110
August	9822	67,339
September	8128	46,133
October	4458	26,041
November	2394	19,716
December	1682	20,714

If the cause of this summer's increase is investigated, it is found to be due largely to a marked increase in the proportion of deaths from diarrheal disease. These, in turn, are found to be very much more frequent among bottle-fed infants than among the breast-fed. At one time it was thought that the chief factor in the association of diarrheal disease with bottle-feeding lay in the improper modification of cow's milk, and much emphasis was therefore laid on methods designed to make cow's milk similar to human milk.

Thanks to the fundamental investigations, both laboratory and clin-

ical, conducted by Park and Holt the attention of physicians and health officers was directed to the quality of the milk supply, and particularly to the bacterial content of the milk, as being directly responsible for the high death-rate from diarrheal disease, especially in the summer months. It is almost impossible to overestimate the beneficial influence of these investigations. Through the resulting improvement of the milk supply they have caused the saving of thousands of lives annually.

The investigations showed especially the very great importance of keeping milk cold so as to retard the multiplication of bacteria. They thus gave renewed impetus to the movement for supplying the poor with ice during the hot weather. In New York City this movement has undoubtedly played an important part in reducing the infant mortality during the summer months. This, then, brings out another close connection between infant mortality and economic conditions, for it is clear that where such ice charities do not exist, many poor people must go without ice during the hot weather.

From a sociological standpoint it is important to recognize the justice of the demands now made by a community to have a clean and safe milk supply. Experience has shown that this can be assured only if strict supervision and control is exercised by municipal or State health authorities. But the community has a right to demand even more, and that is to have such a milk supply made available at a price within reach of the masses. Because of its unique character as an almost indispensable food for children there is a growing disposition to regard the milk supply in the same light as the water supply and to argue for a milk supply controlled and perhaps distributed by the community. In this connection attention may be called to the statements by the New York City health authorities that the increase in the price of milk in 1917 was accompanied by an increase in the deaths of infants from diarrheal disease. In Europe the present marked curtailment of the milk supply is said to have resulted in a large increase in infant mortality.

From the sociological standpoint it is particularly interesting to note there is almost always some degree of parallelism between the infant mortality-rate and the birth-rate. In fact, authorities consider that the decrease in the infant mortality-rate, so widely observed, is due more to the decline in the birth-rate than to any other factor. Flügger expresses himself as follows: "When many children are born the nursing care given the later born is less careful, the family income proves insufficient and the mothers are not able or not willing to nurse the later born at the breast; when fewer children are born these considerations disappear to a greater or less degree and a larger proportion of the children remain alive."

This is well borne out by the two following tables, one from Saxony, in 1885, and the other from the Johnstown survey, 1911. In both tables the infant mortality-rate is shown according to the order in which the child was born. Although the rates in the two tables naturally

differ widely the agreeement between the course of the mortality curve is striking:

	Saxony, 1885. Infant mortality-rate.		Johnstown, Pa., 1911. Infant mortality-rate.
First child	229	First child	143.6
Second child	204	Second child	131.2
Third child	212	Third child	144.2
Fourth child	232	Fourth child	142.0
Fifth child	263	Fifth child	178.1
Sixth child	289	Sixth child	175.5
Seventh child	311	Seventh child	192.1
Eighth child	332	Eighth child	165.4
Ninth child	361	Ninth child	128.2
Tenth child	413	Tenth and later	252.3
Eleventh child	514		
Twelfth and later	597		

The age of the mother also plays a part in the infant mortality-rate Following is a table reproduced from the Johnstown survey:

All mothers.	Infant mortality-rate, 134.
Mother under 20 years	136
" 20 to 24 "	121
" 25 to 29 "	143
" 30 to 39 "	135
" 40 and over	148

Considerable influence is exerted by the character of the attendance at birth, but in studying statistics bearing on this point it must be remembered that difficult cases of labor are more commonly in the practice of physician. Following are two tables bearing on this:

Johnstown Survey, 1911.		Newark, N. J., 1916.	
All births (infant death-rate)	134	All births (infant death-rate)	87.6
Midwife in attendance	179	Midwives in attendance	70.7
Physician in attendance	100	Physicians in attendance	74.3
		In hospitals	97.4

It must also be remembered that certain of the European nationalities are more likely to have a midwife in attendance than are Americans or Irish-Americans. It follows, therefore, that the problem is complicated by the introduction of the nativity-of-mother factor. How great a part this plays may be gauged from the study made of New York City's statistics by Guilfoy. They relate to the year 1915. Guilfoy found that the infants of parents of Russia-Poland and of Austro-Hungarian birth had an extremely low death-rate (80 per 1000). Infants of Italian mothers had a death-rate of 103; those of native mothers a rate of 106; those of German mothers, 115; those of Irish mothers, 119.

In the United States an important factor influencing the infant mortality-rate of any community is the size of the negro population. In New York in 1915 while the infant mortality-rate as a whole was 98.2, that of negro infants was 202, while that of white infants was only

96.2. In one section of the city, the densely populated negro quarter known as Columbus Hill, the infant mortality-rate was 314 per 1000 births.

It must not be supposed, however, that the high infant death-rate among negro infants is necessarily due to some constitutional inferiority of the negro stock. Among the causes for the high rate among negroes, Sobel, who has given this problem special study, enumerates: "illegitimacy, syphilis, tuberculosis, alcoholism, overcrowding, lack of industrial opportunities for men, gainful employment of mothers, low average wages, entrusted care of infants to mammies and irresponsible neighbors, ignorance, superstition, extensive employment of quack remedies and patent medicines."

It should also be noted that the infant mortality-rate is invariably higher among illegitimate children than among legitimate. This is well shown by the following table reproduced from Prinzing, the figures representing the infant death-rate per 1000 births.

1901–1905.	Legitimate.	Illegitimate.
Prussia	179	331
Bavaria	229	321
Saxony	233	329
Württemberg	210	289
Baden	155	298
Germany	188	320
Austria	207	277
France	129	240
The Netherlands	134	223
Finland	135	190
Italy	164	232

Although the figures are small the results of the Johnstown survey were practically identical with those shown in the above table. Thus out of 34 illegitimate infants 9 died in the first year—281; out of 1517 legitimate infants, 187 died in the first year—130 per 1000.

The reasons for this high death-rate among illegitimate infants are not far to seek. Many of the infants are abandoned by their mothers and are picked up as foundlings, sometimes after severe exposure; many of the infants are the victims of baby farming; they are liable not to have maternal care, for the mother has no incentive to keep the infant alive; artificial feeding is especially common, for the mother is usually compelled to go back to some gainful occupation.

The value of prenatal care of mothers is just beginning to be appreciated by health officers. In New York City the infant mortality-rate among mothers supervised by the Bureau of Child Hygiene for some time prior to the birth of the infant is considerably lower than in those not so supervised. How proper prenatal care of the mother directly affects the offspring is well shown in the following table compiled by Merletto-Ferrara, which shows the weight of the newborn infant as affected by the number of days prior to the confinement that the mother could give up active work:

Days at rest immediately preceding confinement.	Body weight of mother. 50 to 60 kg.	60 to 70 kg.
	Weight of infant, g.	
0 days	2752	2903
10 "	2824	3014
20 "	3012	3174
30 "	3034	3223
40 "	3212	3326

One often reads of high death-rates being ascribed by health officers and others to ignorance on the part of the public. In this connection it may be well to call attention to the interesting findings of the Johnstown survey Inquiries made as to the literacy of the mother showed the following:

Among literate mothers—445 births, 62 infant deaths, an infant mortality-rate of 148. Among illiterate mothers—246 births, 49 infant deaths, an infant mortality-rate of 214.

To a large extent many of the foregoing social and economical relations are themselves dependent on one fundamental economical factor, namely, family income. How great a difference in infant mortality is exerted by this factor is well shown by the following, giving the infant mortality-rate in Berlin in 1904:

Infant mortality in the well-to-do sections (Friedrichstadt and Tiergarten)	52.0
Infant mortality in the poorer sections (Wedding)	420.0
Infant mortality in the city as a whole	196.0

The special value of the Johnstown survey (1911) lay in the emphasis placed on the relation between family income and infant mortality. The following instructive table is included in the report:

Father's income.	Infant mortality-rate.
Under $521 annually	197.3
$521 to $624 "	193.0
$625 to $779 "	163.0
$780 to $899 "	168.0
$900 to $1199 "	142.0
$1200 and over	102.0

A similar result is shown in the survey conducted by the Children's Bureau, Manchester, N. H., in the fall of 1914. The figures show the infant death-rate per 1000 reported births:

INFANT MORTALITY-RATE AS RELATED TO FATHER'S EARNINGS, MANCHESTER, N. H., 1914.

Father's income.	Infant mortality-rate.
Under $494	262.4
$494 to $571	145.7
$572 to $675	191.7
$676 to $883	145.7
$884 to $1091	146.2
$1092 and over	53.2

It is obvious that the size of the family income will also determine the character of the family's environment, thus: general character of

the neighborhood, type and condition of house, number of rooms, character of the water supply, whether sewer connection is present, whether outdoor privy is present, whether there is a bath-room, etc.

From what has here been presented it is clear there is no exaggeration in saying that in no other domain of public medicine can more intimate relations be discovered between mortality on the one hand and social and economical conditions on the other than exist among the causative factors of infant mortality. Only by giving the various factors due consideration can we hope to reduce infant mortality to its lowest possible level. In this connection the reader is urged to study Special Report Series No. 10, issued by the Medical Research Committee, London, and bearing the title "The Mortalities of Birth, Infancy and Childhood" His Majesty's Stationery Office, 1917.

MALARIA.

In malaria, as it is observed in our Southern States, we are probably dealing with a disease carried by negro slaves from Africa and constituting one of the disastrous and unexpected consequences of the demand for cheap labor. This disease, morevoer is one to which, the negro, through countless generations of contact with the infection, has acquired a fair degree of tolerance, so that he is able to withstand malarial infection much better than his white neighbor in the South. The result is that where malaria has become very prevalent the physically more resistant but economically less efficient negro has replaced the more susceptible, more efficient white inhabitant. In consequence of this large areas of fertile land, highly suitable for productive agriculture, lie almost untilled. In these sections the railroads pass through great stretches of country, taking on and discharging almost no freight. According to a recent survey made in several counties in Georgia, malaria cost the affected communities not less than $14 per acre of tilled land, surely an enormous economic burden.

But a remarkable change is taking place, so that at present one may find numerous communities waging an energetic campaign against malaria. While Federal, State and local authorities are coöperating, it must be noted that usually more than half of the expense of these operations is being borne by the local communities. Why this rather sudden awakening? There have been no recent great discoveries regarding antimalaria methods, and it cannot all be due to the intensive educational propaganda which the United States Public Health Service has carried on throughout this region nor to the stimulus afforded by the "extra cantonment" health work carried on during the war. The answer is found in the material prosperity due to the high price of cotton prevailing during the past few years, and so we have another striking example of the topic discussed in this chapter.

OTHER DISEASES.

The data given under tuberculosis, infant mortality and malaria will give the student some idea as to the role played by social and economic factors in disease. The examples could easily be multiplied and extended. Thus by consulting the chapter on Industrial Hygiene the reader may note the important part played by occupation in the etiology of disease.

In pellagra recent investigations have shown a marked relation between the development of this disease and a monotonous, unbalanced diet. Similar conditions are observed in beri-beri in the orient. During the recent war a number of observers called attention to various pathological conditions apparently associated with dietary deficiencies, among them war edema, xerophthalmia, war amenorrhea, scurvy and pellagra. In most of these conditions the deficiency was apparently largely in the accessory food substances, the so-called "vitamines." When one considers how easily food supply may be disturbed (war, financial crises, failure of crops, failure of transportation, floods and the like) the influence of social and economic factors on diseases of nutrition will readily be understood.

In typhus we are dealing with a disease associated largely with filth, poverty and ignorance. It is significant that with this disease unduly prevalent in Europe at the present time, little apprehension is felt in the United States, owing to our confidence in the high standards of cleanliness and sanitation which prevail in this country.

CHAPTER XXVII.

PUBLIC HEALTH EDUCATION.

By CHARLES F. BOLDUAN, M. D.

Historical.—Although health education definitely organized as such, as the work of health administrators, is of recent development, instruction in health matters in the form of laws and regulations dates from the remotest times. One of the earliest codes of health regulations with which we are familiar, namely the Mosaic, is remarkable for the fact that many of the regulations are in entire harmony with the recognized principles of hygiene of the present day. This is especially true of the warnings against discharges and eruptions from the body, of the emphasis placed on washing and bathing as a means of purification, and of the explicit directions for proper disposal of excreta.[1]

In ancient Greece and Rome the magnificient public baths (thermæ), the remarkable systems of public water supply including masonry aqueducts which constitute monuments to ancient engineering skill, the enormous sewers (cloacæ), all testify to an appreciation of sanitary requirements. Like so much in other departments of human progress this appreciation appears to have dwindled, almost to the point of disappearance, during the centuries which followed.

With the low standards of medical knowledge prevailing during the dark ages, it is not surprising to find practically no traces whatsoever of activities relating to public health education. After the Renaissance, however, and apparently mainly because Europe was repeatedly devastated by various plagues in the 13th, 14th and 15th centuries, the need appears to have been felt for furnishing authoritive information regarding the dreaded plagues. The result was the publication of numerous leaflets usually spoken of by scholars as "plague tractates." An interesting collection of these by Sudhoff indicates a wide range of titles, including leprosy, syphilis, plague, alcoholism, and sweating sickness. These tractates thus constitute the forerunner of the health leaflets published by present-day health authorities. Interest in matters of health and sanitation appears to have subsided, however, for it is certain that even so recently as two hundred years ago conditions throughout the world were most unsanitary.

A reawakening of interest in public health is observed, mainly in England, in the early part of the nineteenth century, and we find, as a result, that communities concern themselves more actively in the provision of pure water supplies, in the disposal of refuse, the con-

[1] See Especially Leviticus XV, and Deuteronomy XXIII.

struction of better streets, etc., in other words, in matters of municipal sanitation. Let it be noted that these are provided *for* the individual *by* municipal authorities.

Toward the end of the century, especially during the eighties, a remarkable change may be observed. The important bacteriological discoveries initiated by Pasteur and Koch, establishing, as they did, the infectious nature of many common diseases, placed a much more personal obligation on the individual members of the community to safeguard the public health than had hitherto existed. In order, however, to derive substantial aid from the individual it was first necessary to make him recognize the obligation and to instruct him how to coöperate with the authorities. Accordingly, we find health departments undertaking the publication of simple leaflets dealing with the more important communicable diseases. Almost invariably these contain instructions for dealing with a case of some particular infection, and they are distributed, as a rule, only to the families in which such a disease exists. While the fact is recognized that most infections are much more readily prevented than cured, very little is done by the health authorities beyond dealing with the cases of the disease as they occur. For example, in the domain of infant mortality, in which so much progress has been achieved in the past ten or fifteen years, a large amount of effort was expended in hunting out and providing medical care for sick babies in summer time. That this was absolutely illogical and ineffective in combating infant mortality was not then recognized.[1]

Tracing the further development of health education, attention must be called to the campaign begun in the late eighties for the suppression of tuberculosis. Developed more effectively in the United States than anywhere else in the world, this campaign has exerted a profound influence on the methods of public health work generally and on health education in particular. Among the former may be mentioned the introduction of the municipal diagnostic laboratory and of home visitation by public health nurses, the impetus given to the housing movement, etc. Among the latter are the introduction of health exhibits, health lectures, health days or weeks, health primers, health posters, health "movies," etc. Of paramount importance was the fact that the educational campaign was preëminently one of prevention and that it was carried on among all the people, and not, as had so generally been the case before, only among those already ill.

In view of the success attending the campaign against tuberculosis, it was natural to utilize very similar methods in the campaign against infant mortality, cancer, the venereal diseases, etc. Quite in contrast to the lack of success which had characterized the earlier efforts to reduce infant mortality by concentrating attention on the sick babies the application of the preventive educational methods quickly yielded

[1] This activity was initiated by New York City in 1876, when a staff of physicians, known as the "Summer Corps" was organized. The plan was followed each summer for many years.

favorable results. In fact, the contrast was so pronounced that health education came to be recognized as an important function of health authorities.

HEALTH EDUCATION IN THE SCHOOLS.

Health education, like all education, is best begun at as early an age as possible. So far as organized health education is concerned it should begin with the entrance of the child in school and should continue throughout the entire school life. In the lower grades simple instruction is given in cleanliness of the hands, face and teeth, the importance of covering the mouth when sneezing and coughing, the use of handkerchiefs, spitting on the floor, etc. In addition to this it is well to discuss the needs of pure food, pure water and fresh air, the influence of alcohol and tobacco. In the more advanced grades there should be simple instruction in the spread of disease through the exchange of secretions; the value of fresh air and sunlight illustrated by plant life; elementary instruction in food and nutrition, street accidents, first-aid and the influence of alcohol and tobacco.

In the first three years of school the pupil should be told to do things without emphasizing the reasons therefore. Each topic should be related to daily living and should affect daily practice. After the third year the pupils may use text-books; but the teacher should endeavor to ensure the grasp of one or two topics in a lesson and not try to cover too much ground. The result of the instruction should be tested by inspection of the pupils and by observing how well they have formed habits of good hygiene. Student self-governing health leagues may be formed with great profit, and these may advantageously be organized either on the street-block basis or with the class-room as the unit. In fact, both types of organization may exist side by side.

In the high schools the courses in science and biology offer exceptional opportunities for instruction in health matters. Here can be taken up certain important disease germs, such as those of diphtheria, typhoid fever and tuberculosis, milk as a food, bacteria in milk, food and nutrition, food supervision, water supply, sewage disposal, etc. Interest in the work of the health department can be aroused by the courses in civics.

In this connection attention is called to the program of physical training prepared by the Military Training Commission in New York State for use in the elementary and secondary schools.[1] Due largely to the breadth of view of the State inspector of physical training, Dr. Thomas A. Storey, "physical training" as provided for this program, is construed as covering (*a*) individual health examination and personal health instruction; (*b*) instruction concerning the care of the body and concerning the important facts of hygiene (recitations); (*c*) physical exercise as a health habit, including gymnastics, elementary marching and organized supervised play, recreation and athletics.

[1] Under the authority of Chapters 566 and 567, Laws of 1916, New York State.

The educational possibilities of such a program are great. As adopted by the Board of Regents it calls for a total of six hours a week of school time on the part of each child in all the grades in every elementary and every secondary school throughout the State. It provides for a correlation between the class-room teacher and the school medical inspector; provides short, refreshing setting-up drills four times each school day; emphasizes good posture; devotes at least one hour, and not more than four hours, per week to directed recreation; includes at least two periods weekly, of thirty minutes each, for gymnastic drill, and marching, and finally provides for at least twenty minutes a week to recitations on care of the body and on important facts of health.

Given a realization of the surpassing importance of good health, the ways in which health topics can be introduced into the school curriculum are practically endless. While the first point of attack is naturally through the formal courses dealing with hygiene and physical training, an alert teacher will not overlook the opportunities presented by the assignment of health topics as subjects in English composition, by health problems arthmetically presented, by a study of the health department under the head of civics, and by careful instruction in personal hygiene, under other appropriate headings. In the upper grades and in the high schools the preparation of simple graphs dealing with vital statistics offer a means of making public health problems a reality to the pupils. The art classes can coöperate with the health authorities in the preparation of posters; the domestic science classes can be interested in teaching the relation of nutrition to health; the classes in chemistry and biology are prepared to study the work of the health department's laboratories.

Health officers are in danger of forgetting that many of the health data which they have at their fingers' ends are quite unfamiliar to many teachers. This is especially true of the more recently discovered facts, and is more apt to be encountered among teachers without college training and among the older generation of teachers. In furthering the more formal classroom instruction in health matters the health department should therefore see that every assistance is given to the teachers in the way of illustrative material, prepared health texts and lessons and that opportunity is offered to teachers and to older pupils to observe the various activities of the department of health.

In addition to the more strictly educational methods just outlined, knowledge concerning health matters should also be imparted through the work of the school doctor and the school nurse. A system of school medical supervision which does not constantly aim to teach the pupil the significance of the various medical examinations and of the action taken as a result of such examinations is doing only a small part of its work. Wherever possible the work of medically examining school children should be so arranged that the child's parent is present. It is remarkable how much better coöperation can be secured in this way and how well this opportunity lends itself to effective health education.

The schools can be utilized still further in promoting health education for they are extremely useful as a means to reach the adult members of the community. To this end the schools are made the center of rallies, celebrations and similar "features," and the children serve as carriers of health messages into the homes of their parents. The latter is most simply accomplished by means of printed leaflets, etc., but it is throwing away golden opportunities to make the children merely mechanical carriers of printed leaflets. Whenever possible the message carried by the leaflet should also be given directly to the children, in the form of a simple lesson, which they can understand and which they can then carry into the home by word of mouth.

NEWSPAPERS IN HEALTH EDUCATION.

While perhaps the most effective and most lasting health education is that acquired in childhood, adult education is highly important and should not be neglected. In fact, there are subjects that cannot well be presented to children, among them matters relating to industrial hygiene, venereal diseases, sex hygiene, etc. Of the various means of furthering health education among adults, none exceeds in influence the newspaper. There is still a great deal of misconception of the way newspapers can be utilized for this purpose, and such misconception often leads to unjust criticism, both of the health officers and of the newspapers.

It is well to recognize that the newspaper can be used by health departments for two different purposes, both of them legitimate, namely, (1) advertising and (2) educational publicity. The service which advertising, *i. e.*, mere publicity can render is often overlooked; in fact, now and then we hear it criticized as undignified. Yet merely keeping the ordinary doings of the health department before the public by means of news articles is of invaluable aid in enlisting financial and moral support for the department's activities. It is natural, too, that the public should like to know how its money is being spent. Experience shows that necessary funds will more readily be voted to a health authority whose activities are known to the public. In a measure such chroniclings also have an educational value; their main purpose, however, may be said to consist in keeping the doings of the health department before the public, *i. e.*, in legitimate advertising.

In contrast to the preceding, newspapers can be used for the dissemination of educational publicity. This is much more difficult to handle and requires considerable judgment, a keen sense of what constitutes "news" and a knowledge of local newspaper conditions. In this connection, however, it is well to differentiate between the large metropolitan newspapers and those published in smaller towns. In the former, space is at a premium and difficult to secure; in the latter, conditions are usually quite the reverse; the editor welcomes good readable material to fill his space. This is especially true when the material is supplied to him free of charge in the form of "patent

insides" or "boiler plate." By this is meant material supplied in the form of metal castings (stereotypes), ready to put into press. A number of commercial "press associations" make a business of handling this kind of newspaper work. Copy is supplied to them in typewritten form, they submit proof and for a given consideration arrange for the publication of this material in a given number of newspapers. For educational work by State health departments this is a very desirable method of handling the newspaper activity. It has the distinct advantage that the text and the amount of space is absolutely in the control of the health department, and one knows exactly what return in newspaper space is being obtained for a given expenditure.

Very few of the larger newspapers make use of ready-to-print plates, and this method of securing the publication of educational health articles can therefore not be utilized to advantage in reaching the people of the larger cities. These newspapers, however, may be very willing to make use of articles, preferably illustrated, supplied in the form of stereotype matrices, or "mats" as they are usually called. It is well to have the mat comprise an article two or three columns wide, or even the width of a page, and occupy a length of from four to nine or ten inches. A picture is almost indispensable in order to secure any considerable proportion of publications. These mats can readily be sent through the mails and they constitute an extremely convenient and economical means of securing the publication of articles in the exact form in which they are prepared. When supplied in quantity, say fifty mats, or over, they can be laid down in the newspaper offices at a cost, varying with the size, of from fifteen to twenty-five cents.

In the large metropolitan newspapers educational articles on health are usually accepted most readily if they are connected with some item of news. At the same time it is rare even then to find extended space given to the educational part of the bulletin sent out. No matter how important, from the health officer's standpoint, the educational part of the bulletin will usually suffer extensive cuts or may be deleted entirely. There is really no way of avoiding this and the problem, therefore, becomes one of presenting the material in some other form.

It would be a mistake, however, to believe that the large metropolitan newspapers cannot be utilized for educational health notes. The fact remains that whatever material of this kind does find publication in such newspapers is read by millions of people, and therefore exerts a very wide influence. The alert director of health publicity will know how to make use of innumerable news happenings about which to write a brief educational note. After all the frequent publication of short health hints in this way is probably more effective than the occasional publication of a lengthy health article, for many people will not bother reading the letter while the former can hardly escape being read by all.

It is often of interest to determine how widely a given article is read. This can be done by means of an offer to supply something on request. Moreover, if one desires, it is a simple matter, by the use of a

key, to determine which particular form of announcement brought the response. For example, one may be in doubt concerning the necessity of preparing copy for certain foreign language newspapers. A few tests of this kind will soon supply a reliable answer.

While on the subject of foreign language newspapers it may be pointed out that while English copy is extensively utilized, better results are obtained if material is already translated. Unless, however, a trained, fluent writer is available it is better to send English copy.

A word now as to the preparation of a press bulletin. If a health department plans to make rather extensive use of press bulletins, or if the number of newspapers served is considerable, it is well to employ a printed blank form.

The bulletin itself may be either typewritten, multigraphed or printed. If it is typewritten care should be taken that the carbon copies supplied are legible. For a moderate-sized press service one can make as many as fifteen to twenty legible carbon copies by the employment of what is known in the trade as "onion paper." For numbers larger than this it is well to make use of a multigraphed reproduction. When the number of copies to be sent out reaches several hundred it is advisable to consider printing the bulletin. Printed press bulletins are extremely useful when limited funds make it impossible to send out bulletins very frequently, but where, nevertheless, a large number of publications are to be served. Under these circumstances the type of bulletin technically spoken of as a "clip sheet," employed, for example, by the American Society for the Control of Cancer, by the United States Public Health Service and by the American Medical Association is to be recommended. This usually consists of a large printed sheet containing a number of articles, some long, some short, some simple, others more technical, thus permitting a selection to be made by the editor to whom they are sent. Effective work can be done by supplying a considerable number of short items—two and three lines each. These are spoken of as "fillers," and are welcomed in all newspaper offices.

In writing the press bulletin it is advisable to follow a custom common in most newspaper offices and tell the story at least twice, first in condensed form in the opening sentence or paragraph and then in more detail. Sometimes still further elaboration can follow this. The advantages of this method are several. Even if the entire bulletin is printed, many readers will not pass beyond the opening paragraph, perhaps only a few will carefully read the entire article. If lack of space make it necessary to cut the article this is easily done without mutilation. Even if only the opening paragraph is printed, something will have been accomplished.

In giving to the newspapers information constituting a news item it is imperative that the information be given to all the newspapers. There must be no favoritism. In a large city most of the newspapers receive the service of some news agency, and when this is the case it will often suffice to give the news items merely to this agency.

For State or national work one should make sure that the several large news gathering agencies, Associated Press, United Press, International News Service, etc., are supplied with the bulletin. While the ethics demand that the original news bulletin be supplied to all the prominent newspapers or news-gathering agencies, they also demand that any information solicited by further inquiries on the part of some one newspaper reporter be regarded as belonging, for the time, to that reporter. The health officer should not volunteer such information to a rival reporter, though, on the other hand, he should not withhold it if direct inquiry is made. Careful observance of the just rights of the reporter and recognition of his duties to his newspaper will quickly make him not only a most valuable educational factor but also a friend who can be trusted.

Careful judgment should always be exercised as to publishing names of individuals in connection with health department activities. For example, an inspector finds a lot of spoiled food on the premises of a butcher. He promptly denatures the stuff and serves a summons to court on the owner of the establishment. Is the name of the butcher made public? A localized outbreak of typhoid fever is traced to a milk supply sold from the wagons of a given dealer. Is the name of the dealer given to the press?

In deciding on the course to pursue one should bear the following in mind: The fact that the spoiled food was found on the butcher's premises does not in itself prove the butcher a scamp, deserving of publicity and odium. He may have a reasonable and convincing explanation and may be wholly innocent of wrongdoing. Moreover, if an innocent person is thus held up to public scorn he might have good grounds for a libel suit. It was the writer's practice, in handling the publicity work of the New York City Department of Health, never to publish names in these cases until after a conviction in court. Once that had occurred, there was no reason for withholding the name of the one convicted; in fact, there was every reason for giving the matter wide publicity.

In the case of the milk dealer, whose milk carried typhoid infection, no name should ordinarily be mentioned unless one could prove that the dealer had knowingly and grossly violated sanitary regulations. In most cases of this kind, however, the dealer is the victim of circumstances, and he will be far more ready to coöperate if he knows he can expect just treatment at the hands of the health authority.

In addition to the various educational items, and to the publicity news notes sent to all the papers in practically identical form, most newspapers will make use from time to time of feature stories. These are not news items and a given feature story is supplied to only one particular paper. In fact, it is not good form even to let other writers know just what feature stories are in preparation or to give out identical material to several papers. As a rule, illustrations are welcome. If these are in the form of photographs, glossy prints should be supplied. Simple graphs are sometimes accepted. The style of these

feature stories varies: sometimes they are wanted in the form of an interview with the Commissioner of Health or some other prominent health official; often the editor prefers a human interest story. A large number of special writers make a business of writing such articles for magazines, newspapers, etc., and they should be encouraged to come to the Health Department for material.

An excellent vehicle for the dissemination of health information is that furnished by a "Health Column," supplied to newspapers and conducted on the question and answer plan. Such a column, to be sure, entails a considerable amount of labor, but when properly managed constitutes a powerful educational factor.

Following is a sample of the daily health column conducted by the U. S. Public Health Service. It will be observed that the material consists of a short health article, together with several answers to questions from correspondents. By selecting suitable questions for reply through the column, a large reading clientele can be interested in matters pertaining to health and preventive medicine.

Uncle Sam, M. D.

A daily health column conducted by the United States Public Health Service

BY DIRECTION OF RUPERT BLUE
Surgeon General, U. S. Public Health Service.

DYSPEPSIA.

Dyspepsia is only a symptom of disease, and is often not due to disease of the stomach itself.

Dyspepsia may result from nervousness. Emotional dyspepsia is very common. Everyone knows how bad news or worry will interfere with digestion and be followed by distress after a meal.

Consumption is often accompanied by stomach trouble; in fact, this may be the only complaint made by a patient suffering from this disease.

Disease of the heart especially such as causes stagnation of blood in the abdominal organs; of the liver, such as is produced by alcohol or gallstone; of the intestines, particularly if there is constipation or obstruction of the free passage of the bowel contents; of the kidneys, as in chronic inflammation of those organs, where the waste products of the body are not fully eliminated; of the brain, as where there is a tumor or inflammation of the cerebral membranes—all give rise to stomach symptoms.

Sufferers from dyspepsia should therefore seek competent medical advice, and have the doctor find the cause of the symptoms.

* * *

QUESTIONS AND ANSWERS.

Q. Is whooping cough a dangerous disease?

A. Decidedly yes, especially in young children. The greatest danger of spreading the disease is in the first week or two. Do not let your children play with other children who have a suspicious cough. If there is whooping cough in your neighborhood try and keep close watch over your children, especially when they play with other children.

Q. Who can give me confidential advice on veneral disease. I have not enough money to undertake the treatment if it costs too much.

A. Apply to your city, or state health officer. Very probably there is a clinic in your city where free treatment is given. Helpful leaflets may be obtained by writing to the United States Public Health Service, Veneral Disease Division, 228 First st., Washington, D. C.

The use of paid advertising space for health department publicity is generally open to criticism. Now and then it may be advisable to resort to this method of securing newspaper space, but even then the propriety of thus using public funds may be questioned. This objection is not entirely overcome by having the advertisement paid for by some private individual or civic organization.

Uncle Sam, M. D., Gives

Health Advice

Written by Experts Under Direction of Dr. Rupert Blue, U. S. Public Health Service.

Questions and Answers

Q.: I was discharged from the army eight months ago and, despite all I can do, cannot get rid of an annoying reminder of my service, namely, cooties. What would you advise?

A.: You probably are entitled to free medical care under the provisions of the war risk act. Please send me your name and address and I will see that the matter is referred to the proper authorities.

Q.: I am a high school student, studying biology. Can you tell me all about sewage disposal?

A.: To do so would require a book. If you will send me your name and address I will send you some helpful pamphlets, which will probably give you all the information you desire.

Q.. What is "winter cholera?" Is it Asiatic cholera? How is it spread?

A.: The term is loosely used. Mostly it is applied to a diarrheal disease caused by drinking infected water. Sometimes investigation has shown it to be simply an epidemic of typhoid fever. Such water-borne epidemics are more apt to come in winter and spring as a result of rains and freshets polluting water supplies.

In many communities a task of no little magnitude is that presented by the misleading medical propaganda of the patent medicine faker and the charlatan. The income derived by certain newspapers from this class of advertising is enormous and will rarely be given up except under some form of compulsion. Here and there, to be sure, newspaper publishers will recognize the advantage gained by excluding such advertisements, and when this occurs a flank attack can be conducted against these newspapers which still carry the objectionable advertising. In this connection it may not be amiss to call attention to a vicious form of contract employed by many of these advertisers. This provides that the contract to advertise becomes void if any legislation is

passed inimical to the interest of the advertiser. It is clear that this almost automatically causes the influence of the newspapers handling this form of advertising to be exerted against any legislation intended to control or prohibit objectionable patent medicine advertising. It is well to dwell on this fact when addressing the general public on the patent medicine evil.

Before leaving the subject of newspapers in health education it may be well to call attention to the surprising value of personal contact established between the health officer and newspaper editor. Such a contact will serve to teach the health officer what constitutes "news," what kind of material will secure publication and what form is best adapted for newspaper presentation, In addition to its value to the health officer such contact will also be of assistance to the editor, for it will serve to make him much more directly familiar with the work of the health department and will make him more sympathetic toward the work to be undertaken by the health officer.

Periodic Publications.—In the larger cities the publication of a health bulletin will be almost indispensable. In the smaller cities and towns such a bulletin may also be made a valuable educational agent, but to a large extent its place can be taken by the local newspaper.

There are several reasons why the larger cities should issue health bulletins; perhaps the most important is the fact, already mentioned in speaking of metropolitan newspapers, that it is difficult to get the newspapers to devote much space to merely educational articles and practically none whatever to statistical tables. Another reason is the valuable bond established by the bulletin between the health department and the readers of the bulletin. Still another is the fact that the bulletin can be made a convenient permanent record of the health department's activities. Finally, the bulletin can serve as a valuable text in health teaching in the schools.

In the preparation of such printed bulletins one should have clearly in mind the group of people to whom the bulletin is to be distributed. It is practically impossible to prepare a bulletin that will be interesting and instructive to all elements of the community. If the readers constitute what may be termed the intellectual leaders of the community, city officials, school principals and teachers, physicians, clergymen, prominent business men, etc., it is important not to have the bulletin look like a health primer. On the other hand, if a large edition is to be distributed to the masses one must use extremely simple forms of expression and employ numerous pictures. In very large cities health departments may find it profitable to publish both kinds of bulletins. By sending the more technical bulletin regularly to every physician, school principal and druggist in the city the health department can obtain a large amount of coöperation which otherwise is lacking.

In the preparation of text for these bulletins it is important not to publish ponderous scientific articles whose appeal, after all, can only be limited. Tables may be used in bulletins issued to a selected,

intelligent group of readers, but even then they should be of the simplest kind. For the purpose of making simple statistical comparisons the use of graphs is greatly to be recommended. The expense of reproducing such graphs in the form of line cuts is small. For an excellent description of graphic methods the reader is referred to the very helpful and suggestive book by Brinton.[1]

Fully as important as the text of the material published in these bulletins is their typographical make-up. The type employed should be selected with care. Eight-point or ten-point type, set single leaded, with headings in heavy face capitals and subheadings in heavy face upper and lower case make a pleasing appearance. Subordinate matter can be set solid or in smaller type. Two narrow columns on the page are perhaps a little easier to read, but the advantage is hardly sufficient to compensate for the disadvantages when it comes to make-up, *i. e.*, arrangement of material on the page. This drawback is especially felt when it is necessary to include tables which are wider than a single column.

Distribution of the Bulletins.—The question of distributing the bulletins will have to be answered entirely according to the class of people which one desires to reach. In distributing large editions of popular bulletins prepared to reach the masses directly one will find the public schools, boy scouts, Junior Police and similar organizations, convenient and effective distributing agents. It is rare, however, to have periodic bulletins available in sufficient quantity to distribute so lavishly. Most health departments mail their periodic bulletins, and when this is done one will naturally desire to secure the second-class mailing privilege. So far as State boards of health are concerned their periodic publications are admitted to the second-class mailing privilege under the Act of August 24, 1912. The same is true of publications of a strictly scientific character issued by an incorporated institution of learning. City boards of health, however, cannot mail their publications as second-class mail under the provisions of this act. In order to secure the second-class mail privilege, city boards of health can make application under the Act of 1789, which provides for periodic publications sent to a *bona-fide* list of paid subscribers. It may be well to remember, however, that monthly publications, even when they have been admitted to the second-class mail privilege, must pay regular postage rates (for printed matter), if they are addressed for delivery within the limits of the post office of mailing. This does not apply to weekly publications.

In the work of State health departments, effective aid can be given to local communities by supplying the latter with a special edition of the State health bulletin. This is modeled on the plan devised by the writer and successfully pursued by the New York City Department of Health in providing a local monthly health bulletin for twenty different sections of the city. Each section received an edition of five thousand

[1] Graphic Methods for Presenting Facts by Willard C. Brinton, The Engineering Magazine Co., New York, 1914.

copies of a four-page monthly bulletin, and while the second, third and fourth pages were identical in all twenty bulletins the first page was individual and carried a distinct title, together with health notes pertaining to that particular section of the city.

In addition to periodic publications, such as a weekly, monthly or quarterly bulletin, it is desirable always to have on hand a considerable supply of health leaflets in great variety. They are needed in connection with many other activities, school work, baby health stations, industrial hygiene, tuberculosis campaigns, work against flies, mosquitoes, etc. Such leaflets should be attractive but inexpensive, for they are intended for wide distribution. Placards and pictures bearing on most of the same topics are extremely useful in calling public attention to some special activity; they can be displayed in store windows, posted in shops and factories, on school bulletin boards, fences, etc. Attention has already been called to the making of picture poster designs by students in the art classes in the high schools. It is a plan possessing many advantages and should not be neglected.

In the making of posters a number of considerations deserve attention. It needs no explanation to show that four-color lithographs are far more expensive than posters in one color from a zinc cut. A careful study of some of the posters used in connection with the war drives and the various Liberty Loans will convince any unprejudiced observer that some of the most effective posters were printed in only one color. To be sure, they were usually not black on white but rather brown on buff, or dark blue on gray, or some similar pleasing combination which gave practically a two-color effect.

While there are some advantages in printing the posters on heavy stock (light cardboard) the distribution and the expense when this material is used usually presents great difficulties. It is generally advisable, therefore, to print posters on heavy paper (sixty pounds) and so make it possible to distribute the posters by mail, either in the form of a soft roll or in a mailing tube. The usual sizes for such poster are 40 inches x 30 inches, 30 inches x 20 inches, or 20 inches x 15 inches.

In rural work, where it is planned to use posters outdoors, muslin will be found preferable to paper bill boards. Metal signs may also be used, but the expense is considerable.

So far as lettering is concerned it is well to remember that the message on a poster should be so short as to be taken in almost at a glance. An overabundance of text usually causes the reader to pass on at once. The same is true of the excessive use of capital letters. For excellent suggestions on lettering see Routzahn's book on *Exhibit Planning* and Brinton's work on *Graphic Methods*.

EXHIBITS.

An educational vehicle of great power in selected cases, but one whose proper utilization requires not only study and preparation but also, usually, a considerably outlay of time and effort, is the health exhibit.

The advantages of this method of popular appeal and education are several;

1. An exhibit can be made so striking as to attract the attention of people who would not go to a lecture or read a pamphlet, or otherwise become informed on the subject exhibited.

2. It is a quick method of presentation, gives ideas in a form readily grasped and appeals to all sorts and conditions of men.

3. It brings people together and facilitates an interchange of talk concerning the subject of the exhibit. Moreover, an exhibit demonstrator can answer questions while a pamphlet can deliver only one message.

4. It makes possible the focussing of public attention on one idea during a brief period to such an extent that the subject becomes a live issue for community discussion.

Realizing both its advantages and its limitations the public health exhibit, in some form or other, may well be utilized in every organized campaign of health education. In the case of State health departments or other organizations called upon to supply exhibit material for many different localities it is well to remember that great damage usually results from careless handling and packing, installing and shipping of exhibit material from place to place. This applies especially to so-called "three dimension material," *i. e.*, models and the like. The glass of framed pictures is very readily broken and the same is true of a display of laboratory apparatus. For these reasons, portable exhibits are most satisfactorily made largely in the form of printed poster panels, and this material is supplemented, as occasion offers, by the three dimension material obtained locally.

Where an exhibit is to be installed for a considerable period, say for from one to six months, a great deal of interest can be aroused by the use of models making use of some movable device. A number of effective models of this kind are now supplied through commercial channels.[1]

In a small community it is surprising how much can be accomplished by well-planned exhibits occupying less than a single show window of some prominent store on the main street. An effective exhibit of this kind was utilized by the writer in connection with an antimosquito campaign. It consisted essentially of two panels bearing photographs and legends describing antimosquito measures. Between these panels was the main attraction, namely, an aquarium filled with water swarming with living mosquito wrigglers. An electric light behind the aquarium served to make the exhibit more conspicuous.

In connection with a poster contest among high-school children a well-attended exhibit can usually be arranged by displaying all the posters received during the competition.

During special feature campaigns considerable aid can be obtained by having the local merchants dress their show windows in line with the subject being featured. Thus, during baby week dry goods stores

[1] Educational Exhibition Company, Custom House Street, Providence, R. I.

make a special display of baby clothing, layettes, cribs and nursery fittings; drug stores make a display of nursing bottles, baby scales, pasteurizers, baby powders and the like; jewelry stores feature baby spoons, baby pins, teething rings and silver rattles. During a clean-up campaign hardware stores displayed rakes, garden hose, garbage buckets and paint; grocery stores display soaps, washing powders, ammonia, and scrub brushes; drug stores display disinfectants, vermin killers, fly papers, soaps and the like. A little thought will show numerous ways in which the campaign can thus be assisted by the local merchants.

LECTURES.

Within a restricted sphere of usefulness popular health lectures are of distinct value in public health education. Many of the lectures at present given by health agencies are almost worthless. The mistake is frequently made of inviting as lecturer someone who while an authority in his special field, is without any qualifications as a public speaker. As a matter of fact, for a popular health talk it is far easier to coach a good public speaker so as to be familiar with his subject than it is to get a specialist to deliver a good popular talk. Another common mistake is to have too long a lecture and make no provision for a discussion and questions. Twenty minutes is enough for the lecture proper, and then there should be at least twenty minutes more of discussion and questions. It will not do to leave the latter to chance. In order to obtain the best results, even after a good lecture, it is well to provide for a few in the audience prepared with questions and topics for discussion. This will often stimulate others to participate in the meeting and will help to accomplish the object of the lecture.

When stereopticon pictures are shown the time must be extended, though even here it is not uncommon to find the audience imposed upon by too long a presentation. Forty minutes for the illustrated lecture, with the usual period for discussion and questions, is the usual safe limit.

With the widespread use of moving pictures it may not be amiss to utter here a word of caution. Unless one has a moving picture which can stop with the picture on the screen it is a mistake to attempt to give a lecture while showing a moving picture. The combination is most distracting and fails utterly to convey any clear message. With the fire-proof film, such as are shown, for example, in the Pathescope machine, the picture can be stopped at any one point, and then with the picture at rest on the screen a few remarks can be made. Then the showing of the picture is resumed.

In this connection attention may be called to the fact that stereopticon slides on health topics may be borrowed from various State and local health departments, from the United States Public Health Service and from a number of organizations engaged in health work (National Association for the Study and Prevention of Tuberculosis, American

Society for the Control of Cancer, American Social Hygiene Association, American Museum of Safety and others).

So far as possible, all the slides should be supplied with legends which will appear on the screen. There are many times when it will be desired to use slides without a lecturer, and when this is the case it is imperative to have a descriptive legend which will be part of the picture flashed on the screen. By the use of slides with proper legends an interesting exhibit can be conducted at night in store windows by the use of lanterns which display the set of slides seriatim. Such an apparatus, known as a "stereomotorgraph," is also an attractive feature of a health exhibit.

In conducting feature campaigns it is sometimes desirable to make use of lantern slide announcements repeatedly flashed on the screen in moving-picture theaters. Or it may be desired to have moving-picture theaters flash certain standing announcements for a considerable period, such as "Cover up your coughs and sneezes," or "Please do not spit on the floor in public places." Whenever slides are to be used repeatedly in this way, the breakability of glass slides must be borne in mind and the use of brass stencil slides or of mica slides may be considered. When identical slides are used in considerable number, their expense is much reduced from what is ordinarily charged. At the present time, for example, identical slides in quantity of ten or more can be had for about ten cents apiece.

MOVING PICTURES.

As one contemplates the present tendencies in moving pictures, one one cannot help but notice the enormous vogue of the so-called feature, usually a five- or six-reel drama which occupies nearly one and one-half hours of the spetactor's attention. Recent health films have apparently copied this plan and now one sees a number of health films, *e. g.*, on venereal diseases or tuberculosis, whose showing requires four, five or even six reels. Practically all of these pictures tell a health story in the form of a human interest drama, usually a love story. The writer seriously questions the value of this form of teaching. In most instances the spectator recalls mainly the love story and forgets all about the lesson which is really the chief theme of the picture. The writer is convinced that far more effective health teaching can be carried on by means of simply descriptive and informative moving pictures, usually a single reel in length, often even better, "split reels," *i. e.*, about half a reel. These tell their story in from seven to fifteen minutes and give simple health facts in a form easily understood and remembered. Such pictures can be purchased from a number of producers, among them National Motion Pictures Corporation, Indianapolis, or they can be rented from the Beseler Educational Film Company, 71 West 23d Street, New York.

It is perhaps natural that health officers and others conducting educational campaigns should seek to show such moving pictures as

part of the health mass meeting or exhibit material. In general, however, it will be found that this plan presents a number of difficulties. Thus, in most States there are definite laws governing the construction of places where moving pictures are shown. These laws relate to fire exits, seating arrangements, stairways and the like. Moreover, they usually prescribe the use of fireproof booths for the moving-picture machines and operator. Practically all of these difficulties can be overcome if the picture is shown at an established moving-picture theater. For this reason it has been the practice of the writer to loan health films to such theaters and have them shown as part of the regular program. With only a single reel at a time showing perhaps a different health reel each day for a week, or on the same day for several successive weeks, a large amount of educational propaganda can be conducted with a minimum of effort. There is another advantage in this form of procedure: When showing a number of health movies at a health exhibition conducted by the health authorities or other welfare agency one deals with a group of spectators who are usually unappreciative and inattentive because they are seeing a free show. This is not the case when the picture is shown in the regular program of the moving-picture theater, for there the spectators have paid an admission fee and want to see all that they can. Psychologically it is usually poor policy to give free health movies.

The objection just mentioned has been considered by the various producers of the feature films on health topics. Among these are the well-known pictures "Fit to Win" and "Open Your Eyes," dealing with venereal diseases. Both of these are features, that is, five- and six-reel pictures, and are being exhibited on the same basis as other commercial pictures. They are not shown free, and they have apparently been very successful commercial undertakings. It must, however, be remembered that these deal with six matters, in which interest is very great. It is extremely doubtful whether any other health topic could be handled on this basis. The writer believes that an undiluted health story, in a reel or less, offers a far less expensive and fully as effective vehicle for health education.

In order to overcome the difficulties attending the showing of ordinary motion pictures a number of concerns have prepared non-inflammable pictures to be shown by means of small portable machines (*e. g.*, the Pathescope) in school rooms, assembly halls, factories and the like. Unfortunately this requires the use of special films, and these are not always readily obtainable.

PHYSICIANS.

It is a regrettable fact that a large part of the physicians, especially those in the remoter rural districts, are greatly in need of health education. It is not uncommon to meet physicians who practice medicine along the lines taught over forty years ago who do not believe in the mosquito theory of malaria and who do believe in sewer gas,

the spread of disease by fomites and other relics of a bygone age. But even among physicians whose purely medical and surgical knowledge is fairly abreast of the times it is not uncommon to find many who do not realize how imperative it is that all physicians should become health teachers. These consider their work done when they have examined the patient, made a diagnosis and given suitable directions for taking the prescribed medicines. Yet how well do we not know that this is only half the duty performed. What is the patient's occupation? Just what duties does this involve? Under what conditions are they performed? These and a host of other questions would often lead to a discovery of underlying causes of the patient's illness, only temporarily relieved by the prescription so quickly written out. Moreover, and this failure is equally common, has the physician inquired carefully into the family conditions? In the case of a communicable disease, has he taken all steps necessary to safeguard all members of a family and the community as well? Has he demonstrated exactly how bedside hygiene is to be carried out? In case of a reportable disease, or even of such a condition only suspected, has he notified the health authorities?

Last, but perhaps the most important of all, does the physician take an active interest in community health and welfare? Does he know that the drinking water is safe? Has he pointed out the danger of shallow wells in built-up sections of the town? Has he familiarized himself with the milk supply? Has he advocated pasteurizing the milk supply? Has he ever visited the public school and taken note of the sanitary conditions there prevailing? In short, the physician should feel it a responsibility to act as one of the health guardians of the community. This, to be sure, is an ideal condition still far, far away. But health officers should endeavor to enlist the interest of all the physicians in the community and secure their active coöperation in promoting the health of the people. How can this be accomplished? Much can be accomplished by placing the physicians on the mailing list to receive bulletins published by the State Health Department. In addition to this the health officer can secure coöperation through regular attendance at the meetings of the various medical societies and by the judicious organization of advisory committees on various phases of health work.

The holding of health institutes constitutes another excellent means of reaching the physicians. Such institutes may consist, for example, of courses of instruction in contagious diseases (conducted at the contagious disease hospital) or in the administration of salvarsan (at the venereal clinic) or in the diagnosis of pulmonary tuberculosis (at the tuberculosis clinics) or in infant-feeding (at the baby health stations). For all of these the health department will probably have excellent facilities available. Needless to say, such courses should be free to all registered physicians.

Under certain conditions a more lasting impression can be made by strict law enforcement and the exaction of a penalty. Thus in the

efforts of the health officer to secure more complete birth registration, experience appears to show that some physicians will not regularly report their births unless compelled to do so by fear of a penalty for failure to comply with the law. The example of New York City, where birth registration is almost complete, shows what can be accomplished by prosecutions of all offenders. Law enforcement must therefore be classed as an important educative factor.

FEATURE CAMPAIGNS.

An effective method of arousing public interest in health matters is to set aside some one day or, perhaps better, a week to be devoted to some one phase of public health activities. Care must, however, be taken not to overdo the matter, for the novelty soon wears off, and much of the success of these feature weeks comes from their novelty. Examples of successful campaigns of this kind are "baby week," "mosquito week," "clean-up and paint-up week," "tuberculosis week," "health promotion week."

As one surveys the field of activities in this direction it is clear that many of the campaigns conducted among these lines have been successful enough so far as immediate interest and activity was concerned, but it is a question whether all or even many of them have led to lasting constructive results. As a matter of fact every such campaign should seek to effect a definite constructive object. Thus a "baby week" might have as its object the establishment of a baby health center, a health promotion week the establishment of a system of public health nursing, a mosquito week the drainage of certain bit of swamp land, etc. Failing such a constructive result, much of the effort spent is wasted. The activities to be undertaken in connection with such feature campaigns are of almost endless variety. Some idea of this kind of work can be gained from a perusal of the following helpful program issued by the Illinois State Board of Health in connection with its recent "health promotion week."

DISPENSARIES AS EDUCATIONAL CENTERS.

One vehicle of public health education which is still very much neglected is the dispensary. These institutions are peculiarly well adapted to undertake this important work. It is surprising to see, for example, how little use is made of the excellent display space afforded by the walls of the waiting room and corridors of the average dispensary. The patients visiting the dispensary are surely in a most receptive mood and would undoubtedly be greatly benefited by a display of pictures, charts, models and other exhibit material bearing on their condition or on health, generally. Even so careful a student of the dispensary as Dr. Michael, of Boston, makes absolutely no mention of this phase of the dispensary's work.

In addition to the display of the pictures, charts and exhibit material on the walls of the waiting room there should be an ample supply of simply written leaflets of instruction covering practically the entire field of medicine. Certain general leaflets of instruction should be given to every patient; others should be given according to the patient's illness. A beginning has been made by a number of dispensaries which now issue to their patients printed instructions regarding the precautions to be observed and the diet and general regimen to be followed. It is perhaps out of the question for many of the smaller and even moderate-sized dispensaries to undertake the preparation and printing of the leaflets here suggested. This is all the more reason why some central authority, such as the State Health Department, should take up this matter as part of its educational work and provide such pamphlets at cost.

DISPENSARY CLASSES.

There is another important phase of educational work which can be carried on by dispensaries, and that is "class instruction," In fact, for some of the more prevalent diseases and conditions, such as tuberculosis, heart disease, malnutrition, infant hygiene and the like it is a great waste of effort to attempt to give very much individual instruction to patients. Besides the economy of time and effort there are distinct advantages in collecting the patients into classes and giving them class instruction. This comes from the discussion of the problems naturally presented by the various patients and by the questions which they are encouraged to ask. Moreover, there is the stimulation of example set by the more earnest of the patients.

This form of instruction has already been utilized with great success among tuberculosis patients, where, in fact, it originated, and more recently in child hygiene, malnutrition and heart disease.

SUGGESTED READING.

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Brinton: Graphic Methods, The Engineering Magazine Company, New York, 1914.

Syllabus on Hygiene for Elementary Schools, C. Ward Crampton, New York City Board of Education.

Program of Physical Training, by Thomas A. Storey, New York State Department of Education.

Moree: American Journal of Public Health. (Articles on Publicity.)

MacNutt: Manuel for Health Officers (Chapter X, Publicity), Wiley & Sons, 1915.

COÖPERATION AND ASSISTANCE.

The following official and non-official agencies may be counted on for assistance and coöperation in activities relating to public health education:

State Health Authorities.
United States Public Health Service.
Federal Children's Bureau.
U. S. Bureau of Education.
U. S. Department of Agriculture (several bureaus).
U. S. Bureau of Census (birth and death registration).
U. S. Bureau of Mines.
American Society for the Study and Prevention of Tuberculosis.
American Society for Control of Cancer.
American Safety Council.
American Red Cross.
Russell Sage Foundation.
National Committee for Prevention of Blindness.
National Child Welfare Committee.
National Child Health Organization.
Clean-up and Paint-up Organization (St. Louis).
National Child Labor Committee.
Metropolitan Life Insurance Company.
Prudential Life Insurance Company.

CHAPTER XXVIII.

MENTAL HYGIENE.

By AUGUST HOCH, M.D.

The mere fact that in a book on hygiene the desirability is felt to have a chapter on "mental hygiene" is a very encouraging indication that in recent years the importance of mental disorders as a public health problem is getting more and more appreciated. It is necessary, however, to point out at once that the clean-cut indications for preventive medicine which—thanks chiefly to the remarkable advances in bacteriology—we are accustomed to associate with the term hygiene are present in only 20 to 30 per cent. of the cases that enter our hospitals for the insane, namely, in those chiefly in which syphilis and alcohol are the essential causative factors. But in a large group of mental disorders the essential causes seem to be constitutional. This group comprises not only patients who come to hospitals for the insane but also a great many persons to whom the term insanity—a term of more legal than medical significance—is never applied. It is natural that where the chief causes are constitutional, the indications for preventive medicine are not so simple and clean-cut as they are in cases in which the causes are more external. While this very fact may tend to discourage one from any endeavors in the way of prevention, the conscientious psychiatrist will always again be inspired by a conviction that, intricate as the problem may be in such cases, it is after all possible to take in hand an *individual* and, armed with extensive experience, to teach that individual a manner of living which will help to safeguard him from disturbances of his mental equilibrium. But it is precisely because there exists such a complexity of individual factors and because much in our experience is not yet formulated that it is so difficult to give anything like general rules or anything like an exhaustive account. In this short chapter I propose, therefore, when we come to those more intricate problems, to give some general principles—some brief indications of directions—rather than a more detailed account of "mental hygiene" as it should be applied, a task for which obviously none of us would as yet be prepared.

In another way the writer feels that the situation in regard to the mental abnormalities differs from other diseases, and that is, that we cannot presuppose an adequate knowledge of them by even the average physician in the same way as we do in regard to many other diseases. For that reason it is indispensable to give a brief account of the main principles, so far as we know them, which underlie each of the most

important mental disorders and those which chiefly claim our interest when we think of the possibilities that may be open to preventive medicine.

MENTAL DISEASE DUE TO TISSUE CHANGES.

In doing this we must mention the fact that for our purposes we may divide mental disorders into two large groups: The first is one in which the mechanism of the diseases is easily grasped by the average physician who thinks in terms of diseased organs as the primary seat of function abnormalities. This is a group of disorders in which it is clear and evident that the mental changes are the direct outcome of tissue changes in the brain. We will give a brief account of the chief ones.

1. **General Paralysis.** — Anatomically this is represented by a diffuse inflammatory-degenerative process in the brain which depends on the fact that the syphilitic virus (Spirochete pallida) has invaded the nervous system. This knowledge that syphilis is the cause of general paralysis, though it is gradually becoming more widespread, is not yet sufficiently general. It should be as clearly appreciated as the fact that typhoid fever is due to contaminated water, and the like. Pilcz, in statistics on army officers[1] and prostitutes[2] in Austria, has shown that in the former about 4.75 per cent., and in the latter about 1.32 per cent., of those affected with syphilis succumb to this brain disease. It is probable that inadequate treatment of syphilis has something to do with the later development of general paralysis. But there seem to be also other factors which help, possibly factors of stress and strain. There is evidence to show that people who live a simpler life are less apt to develop general paralysis. At any rate Rüdin[3] tells us, *e. g.*, that in Algiers among the natives, in spite of the fact that syphilis is very prevalent, general paralysis is almost unknown. Clinically the disease manifests itself by a peculiar dilapidatio of behavior beginning with a deterioration in the finest mental adjustments, or as Campbell[4] expressed it, of those most complex reactions which are the essence of the personality. With this are often associated a certain elation and grandiose ideas. Soon there supervenes a grosser progressive deterioration of all mental operations with grave loss of memory. Various neurological symptoms, into which we need not enter, accompany the disease throughout its course. It leads to a fatal termination, as a rule, in three or four years after the onset of the first symptoms.

In order to give an idea of the relative frequency of this disease, we may state that according to the statistics of New York State more than 20 per cent. of all the male first admissions to the metropolitan hospitals for the insane are cases of this disease, and that

[1] Mattauschek und Pilcz: Beiträge zur Lues-Paralysenfrage. Ztschr. f. d. ges. Neurol. und Psych. Originalien, viii, 133.

[2] Pilcz: Zur Frage der progressiven Paralyse bei den Prostituierten, etc., Jahrbücher f. Psych. u. Neurol., xxxvi, 65.

[3] Zur Paralysenfrage in Algier, Allgem. Ztschr. f. Psych., 1910, lxvii, 679.

[4] The Nature of the Dementia in Dementia Paralytica, Psychiatric Bulletin, i, p. 316.

throughout the State and among both sexes it is represented by an average of 13 per cent. of the first admissions. It is also of interest to know, *e. g.*, that, as Salmon[1] has shown, the number of deaths in New York State from general paralysis during 1910 amounted to half the number of deaths from typhoid fever. The same writer has also pointed out recently that, since most deaths from general paralysis occur between forty and sixty years of age, this disease is represented in 1 out of every 9 deaths of men during these two decades. The disease breaks out as a late manifestation of syphilis ten to twenty years after the primary infection. For that reason it affects mostly persons in the third or fourth decade of life; now and then it is, however, also seen in the second decade, indeed even in the first, partly as a result of hereditary syphilis, partly as a result of syphilis acquired in early childhood through nursing, and the like.

2. **Cerebral Syphilis.**—Syphilis also gives rise to a small number of mental disorders which differ both anatomically and clinically from general paralysis. They are due either to syphilitic endarteritis or to various meningitic involvement or gumma formations. They differ clinically from general paralysis in various ways, the most striking of which is that they are likely to be less rapidly and less inevitably progressive.

The arteriosclerotic brain atrophies and senile dementias which also belong in this group we need not consider here.

3. **Mental Disorders Due to Alcohol.**—The two types of disorders which we have to consider here are the alcoholic delirium and the so-called polyneuritic or Korsakoff psychosis. The clinical symptoms of alcoholic delirium are sufficiently well known to physicians so that we need not describe them here. About the polyneuritic psychosis we shall only say that this not infrequently begins like a delirium, while after the initial stage the clinical picture is dominated by a peculiar defect of memory, namely, an inability to retain impressions. Associated with it are often symptoms of a peripheral neuritis, with various motor paralyses. Although chronic alcoholism is the fundamental cause, it is not directly responsible for these conditions. We probably have to assume some sort of metabolism disorder which arises on the basis of chronic alcoholism and which in turn brings about these mental diseases. The anatomical alterations in these alcoholic diseases have not been so well worked out as, *e. g.*, in general paralysis. Nevertheless they are unmistakable and constant.

PREVENTION OF MENTAL DISEASES DUE TO TISSUE CHANGES.

If we now consider what problems for preventive medicine arise in connection with this group, we see at once that there are essentially two etiological factors which attract one's attention: syphilis and alcohol. When we consider the fact that *syphilis* gives rise directly to 14 or

[1] Two Preventable Causes of Insanity, Popular Science Monthly, June, 1910; Chapter on Mental Hygiene in Rosenau's Preventive Medicine and Hygiene, Appleton, 1917.

15 per cent. of all first admissions to the hospitals for the insane, this is in itself startling, but in reality it does not give us the entire story which can be told about the influence of syphilis on mental health. It is, above all, necessary to speak in this connection of various studies on the offspring of syphilitic parents.

I shall mention, somewhat in detail, only one study, namely, one on the offspring of parents with syphilitic involvement of the nervous system made by Hauptmann.[1] This investigator examined 43 families, in 35 of which both, in 8 of which one of the parents had either paresis or locomotor ataxia or other known syphilitic involvement of the nervous system, or at any rate presented a positive Wassermann reaction. Among these 43 families there occurred altogether 129 pregnancies. The fate of these was as follows: Abortions, premature births with early death, stillbirths, or death early in life were the result of 57 pregnancies; 13 living children were not examined. This leaves 59 living children who were studied. Twenty of these had evidence of syphilis manifested in the following ways: 2 had hereditary body syphilis; 7 had either paresis or other well-known syphilitic involvement of the nervous system; while the remaining 11 showed positive Wassermann reaction without well-known syphilitic involvement of the nervous system; but among these 11 there were 3 imbeciles and 8 neuropathic or underdeveloped individuals.

This leaves 39 children who presented no positive evidence of syphilis (*i. e.*, no known syphilitic disorder and negative Wassermann reaction). Among those 39 there were: 1 epileptic, 4 with hydrocephalus, 5 imbeciles, 12 who were either psychopathic or underdeveloped or had dementia precox, and only 17 children who were essentially healthy. Only 17 among 129 pregnancies! While especially in the cases of psychopathic and epileptic individuals in which we have no evidence of the disease being directly syphilitic, the relation with syphilis is not clear, and while it must be admitted that direct psychopathic heredity may have played a role, the possibility also exists that syphilis may be responsible by having brought about some vitiation of the germ plasm.

When we take all these facts together, it is obvious what a serious indictment the experience of the psychiatrist adds when we consider the ravages of syphilis and how much impetus that aspect of medicine brings toward a concerted action against syphilitic infection. This is all the more indicated since even with our present methods of treatment we are relatively hopeless in face of by far the largest number of cases which have above been enumerated. The prevention of syphilis is treated in another chapter of this volume. Here we should mention only the fact that undoubtedly all efforts that bring about an early and thorough treatment of syphilis will also help to lessen the mental disorders arising from this cause.

Next we come to *alcohol*. The influence which alcohol has in the

[1] Serologische Untersuchungen von Familien syphilogener Nervenkranker, Ztschr. f. d. ges. Neurol. u. Psychiat., viii, 36.

production of insanity is more difficult to estimate than that of syphilis. There are, however, as we have seen, mental disorders which are specifically disorders of chronic alcoholism, namely, chiefly delirium tremens and Korsakoff's psychosis. But here again if, in gauging the influence of alcohol on the mental health, we were to confine ourselves to these, we would have a very inadequate idea, because, in addition to these, alcohol is a more or less important contributing factor in many cases of otherwise constitutional mental diseases, thus producing especially various hallucinatory and delusional states, or even some forms of excitement and depression, and there is an uninterrupted series from those cases which are essentially due to alcohol, to those for which this cause is only more remotely responsible.

There is no doubt that the serious effect of alcohol on the nervous system has sometimes been overstated, but in addition to the fact that it produces specific mental disorders, we cannot get away from the classical experiments of Kraepelin, who demonstrated plainly the paralyzing effect on the mind of even small doses of alcohol, nor from the experimental proof that alcohol acts on the germ plasm and leads to degeneracy in the offspring. In recent years, to be sure, a certain diminution of the essentially alcoholic psychoses has taken place in the New York State Hospitals which, according to Pollock,[1] has gone hand in hand with a diminution of manifest intemperance in the history of all first admissions to these hospitals, but the specific alcoholic psychoses still represent 8.4 per cent. of all first admissions in men, while intemperance was found in 28.2 per cent. of all first male admissions. While then, as I have said, the influence of alcohol in the production of mental abnormality may have been overstated at times, this makes really very little difference, because there remains much harm that must be laid at the door of alcohol which is responsible for so much disturbance of mental balance in one way or another, manifesting itself in either misconduct, crime, inefficiency, or insanity, all of which bring untold misery to many innocent families. Even with a conservative attitude we must admit, therefore, that, as in the case of syphilis, psychiatric experience brings to the campaign against alcohol impressive facts. This is, of course, not the place to deal with the many ways in which temperance may be fostered. But one fact should be specially insisted upon in this connection. We know that immoderate drinking is often a symptom of a psychopathic condition and that by proper painstaking study it may be possible to determine the real forces at work which push the patient into his destructive habits, a fact which is of importance in considering what individual treatment may do in preventing alcoholic mental disorders. When this is impossible there is essentially one other means of managing these cases, namely, the formation of societies for total abstinence, because it is often too difficult for an individual to overcome a deep-seated habit without the help of a group in which the example and the whole spirit of the group carries him along.

[1] Decline of Alcohol as a Cause of Insanity, Psychiatric Bulletin, ii, 103.

MENTAL DISEASES WHICH ARE CONSTITUTIONAL.

The disorders of the second large group are less clearly understood in their nature. It comprises, to mention only the most common forms, all those cases which have been provisionally grouped under the head of dementia precox and manic-depressive insanity, and the many cases of so-called psychoneuroses and psychopathic personalities which are often not regarded as insanity, yet which nevertheless suffer from mental abnormalities. We may at once state that the various disorders which are here grouped together may properly be regarded as constitutional disorders for reasons which will presently appear. Now one striking feature about these consitutional disorders is that they are not so clearly demarcated as those of the first group, and the conscientious investigator must constantly admit that, much as this may be in opposition to his desire for simplicity and for smooth classification constant transition forms are encountered, partly between the different psychoses, partly between these and the psychoneuroses and psychopathic personalities.

When we took up the diseases of the first group, we were able to start with a description of the physical basis of the various disorders, *i. e.*, the anatomical alterations in the brain which we had every reason to assume to be the fundamental changes; and we could point to the syphilitic virus, chronic alcoholism and to disorders of metabolism produced by the latter. In the disorders of which we are now speaking, we know very little about external causes or changes in metabolism, while anatomical changes have been demonstrated in one group, namely, in certain cases of dementia precox, but for the present we must admit that their relationship to the mental changes is not so clear, nor are they so constant as those in the first group. On the other hand, in contradistinction to the first group, we find that a psychopathic heredity is much more common and, above all, that we see in all these cases a marked tendency for constitutional mental abnormalities to exist more or less throughout the lives of the individuals. It is for this reason that the term constitutional disorders seems appropriate. The mental collapse, therefore, grows, as it were, out of the personality. These abnormal traits of personality are likely to be inherited, yet not in the same sense as, *e. g.*, the color of our eyes or the shape of our noses is inherited, but in the sense that they represent tendencies which undoubtedly can be modified for better or for worse by the influences of the environment. Hence, when we come to the problem of preventive medicine, we shall have to lay stress: (1) on the question of heredity; (2) on the fact that, looked at from one point of view, we have to regard these disorders as the result of an accumulation of bad mental habits which finally lead to a break of compensation, if we may be permitted to use this term in this connection. This, of course, does not mean that there is not a large field for further investigation in these disorders which searches for physical abnormalities associated with them; and for investigation into the relation which

these bear to bad mental habits and to the final breakdown. Indeed we can hardly conceive of any but a physical basis for the underlying constitutional abnormalities. It is, moreover, not excluded that in the dim future we shall be able to find a physical short-cut for improving these constitutional tendencies, but for the present it would be unwise to close our eyes to the fact that our knowledge in this direction is as yet very inadequate but that, on the other hand, we have at our disposal certain means of mental training and of the teaching of proper mental habits which, in cases who are constitutionally not too heavily burdened, will do more or less to safeguard the individual against mental breakdowns. That there are others who, by the intensity of their constitutional bent, are almost inevitably doomed to final wreckage should not discourage us in our endeavors. At any rate, this seems to the writer a more conservative and at the same time a practically more useful attitude than the constant attempt which is made without adequate foundation to regard dementia precox and manic-depressive insanity from exactly the same point of view as, *e. g.*, general paralysis, and to wait with any attempt at prevention until we have a full knowledge of the evidently very complex mechanism of these disorders. To state it once more, therefore, the fact that the conditions here included are called constitutional and are opposed to the more specifically organic ones of the first group is not due to a neglect of the yet vaguely known physical or organic factors which may accompany these diseases, but to the fact that in addition to other common traits, they arise preëminently on a constitutional basis which fact may offer some means of attack.

We will now briefly discuss the most important disorders of this group.

Dementia Precox.—This is a disorder which occurs in individuals who for years or most of their lives have shown certain personal peculiarities. Perhaps the most frequent type is characterized by a tendency of these persons to keep by themselves, not to participate in the pleasures, cares and pursuits of those about them. They are likely to meet difficulties by shirking or going off by themselves. As children they do not play freely with others; they do not make friends easily and later have difficulty in getting into natural contact with the opposite sex. They are apt to be sensitive and stubborn. Sometimes they are so-called goody-goody children, with excellent school records, bookish and interested in "deep subjects;" in general, they seem to get more satisfaction in thought than in practical activities, which later make more demands on one's capacity for adaptation. There are other types, such as the persons who never develop real interests in life but who are fickle, flimsy and without real aim; as children they are often truant. Or there are individuals who are merely dull, lazy and ambitionless. Again we find a type to which belong individuals who are delicate, nervous, with a tendency, even as children, to hypochondriacal complaints, to frequent headaches and indigestion, given to fads and fancies about eating, often selfish and wilful. Few cases of

dementia precox have not had some bad mental habits. On the other hand, it would be very wrong to think that such traits as above described invariably lead to dementia precox.

The breakdown is apt to occur between the ages of fifteen and thirty, sometimes earlier, sometimes later. The clinical picture is characterized essentially by an estrangement from the environment with the development of various abnormal ideas in the form of hallucinations and delusions; or by peculiar mental attitudes and the breaking through of various more automatic mental mechanisms which give the clinical picture its bizarre appearance. It is likely to lead to a permanent defect, not at all characterized by an interference with memory but with more or less pronounced permanent lack of normal responsiveness to the environment. In order to give an idea of the frequency of this disorder, I may say that according to the statistics of the New York State Hospitals for the Insane over 23 per cent. of the first admissions belong in the general group of dementia precox, and that in 1915 over half of the 36,663 patients in these hospitals suffered from disorders thus classified.

Manic-depressive Insanity.—This is a much less formidable disorder, as it does not lead to a permanent defect, though it often appears in recurrent and sometimes frequent attacks. Here, too, we are likely to find that the patients before the breakdown showed certain abnormalities of the personality, more particularly a tendency to marked mood changes or to habitual abnormal moods. The symptom picture may be described as usually dominated by signs which bear a decided resemblance, though in a markedly exaggerated form, to normal emotional reactions, particularly elations (mania) or depressions (melancholia). An idea of the frequency may be gained from the fact that according to the New York Statistics of 1915 over 15 per cent. of the first admissions to the hospitals for the insane belonged to this disorder.

Psychoneuroses.—The so-called psychoneuroses comprise a very large class. Here should be mentioned hysteria, which imitates a great many physical diseases, from mild abnormalities to various motor paralyses, spasms, blindness, inability to speak, and even febrile states. It also may give rise to peculiar states of mental clouding. Then there are other psychoneuroses characterized by compulsion to do certain acts or to think certain thoughts against the better insight of the patient who feels toward these phenomena as toward something which is foreign to his thinking and acting. Patients should also be spoken of who have absurd fears about touching objects, about crossing the street, being in a closed place, going on a railroad train, and the like. There are also the irresistable impulses to steal or do other acts which are not sufficiently explained by conscious reasons. Other states might be mentioned. We will only add that often the habit of alcoholism has a similar neurotic basis. There are also peculiar *aberrations of personality* such as certain types to which we have already called attention in our description of psychoses. To these we may add a few others, such as the phantastic persons who may be pathologically untruthful, those

with undue suggestibility the intensely irrascible, and the anti-social individuals which include certain of the habitual criminals, and finally the various forms of consitutional aberration of the sexual instinct. Whenever these neuroses and peculiarities of personality are marked enough, even the layman recognizes in them distinct deviations from the normal, but there are many cases which are closer to the normal and which also should attract our attention. It is of these especially that we shall have to speak again later on, when we shall call attention to the fact that it is important to recognize health questions in them.

The Increase of Insanity.—In dealing now with the problem of preventive medicine in connection with the constitutional disorders, it may not be out of place to say a few words about the alleged increase in insanity. Although it is difficult to settle the question whether insanity is or is not on the increase, since we do not have adequate statistics of any but the cases in institutions, we can say at any rate that no valid proof has been brought forth that such an increase actually exists. Of course we have statistics which show a marked rise in the admissions to the hospitals for the insane, and we know that this rise is far in excess of the growth in population. Indeed, this is the experience all over the world. But, in the first place, the time for which this marked increase in the admissions to hospitals for the insane has been shown—*i. e.*, the last fifty years at most—is relatively so short that it must arouse our suspicion at once as to the correctness of the view that all or much of it means an actual increase of insanity, because an actual progressive racial deterioration which this would imply, could not possibly come about so quickly in such proportions. Nor do I believe that factors in modern life can be made responsible for it. We are certainly not able to see in any of them sufficiently definite causes of insanity to an extent which would account for any pronounced increase. Moreover, the following facts also point in the same direction: Salmon[1] has shown that if we leave out of the reckoning the exogenous causes, like syphilis and alcohol, "the ratio of the insane to the population would actually be greater in the quiet countryside than in the cities, in spite of their congestion of population . . . and their increased economic stress." On the other hand, we know quite a number of factors which naturally would account for much of the rise in admissons to the hospitals for the insane, factors which concern essentially a changed attitude of the communities and individuals toward mental disorders. Among such factors we may mention the better provision for the care of the patients in the hospitals for the insane; the greater confidence of the public in these hospitals; the difficulties of existence, especially in large cities, which make it harder than formerly to take care of patients at home; the more general and earlier recognition of mental abnormalities, etc. Indeed it is the opinion of various careful investigators who have studied the situation in different countries that when once a certain level of provision for mental disorders is reached

[1] Two Preventable Causes of Insanity, l. c.

the proportion between admissions to hospitals for the insane and population will be a much more stable one.

Heredity and Eugenics.—Coming now to the specific problems in hand, we must, as we have already stated, give our first consideration to the question of heredity and eugenics.

In spite of a certain tendency which has made itself felt of late years to regard the issues of psychopathic heredity as practically settled, owing to the discovery of Mendelian laws in regard to some features of plants and some simple traits or abnormalities in animals and man, we must insist that these questions in regard to the inheritance of mental abnormalities are still far from clear and the situation is undoubtedly much more complicated than would appear from some statements that are made with such confidence. It seems to us, therefore, that instead of giving anything like general rules, for which our knowledge is not as yet adequate, it is perhaps best to illustrate some general tendencies by an example, very much as we did in the case of the effects of syphilis of the nervous system on the offspring. I take this example from an interesting and well-balanced article concerning these questions by Adolf Meyer.[1]

Meyer had four interrelated family groups in a school district of Baltimore worked up in which 522 persons were studied, among them children who were found in the schools to be defective. He makes three groups: The first comprised 11 matings, in which both parents were normal, but in 4 of these matings both parents showed by their family history that their stock was tainted. The result of these was that one of the offspring was defective, and 3 to 6 were normal; while in the other 7 matings, in which but one parent was tainted, "the results were correspondingly better." The second group comprised 9 matings, in which one parent was defective. In the cases in which the defective was married to a normal but tainted individual, the progeniture contained about an equal number of defectives and normals; whereas among the defectives who married normals that were not tainted, there were 2 defectives, 6 uncertain, and 15 normal children. A third group comprised 4 matings, in which both parents were defectives. The result was 21 defectives, 1 sex offender, 4 uncertain, and only 1 normal.

Meyer justly states that what holds for mental defectives, in the sense of imbecility or epilepsy, holds also for mental diseases, by which undoubtedly he means the mental disorders of which we have spoken above as constitutional, but that in this it is fortunately not the inheritance of an actual condition with which we are dealing, but rather an inheritance of a disposition to abnormality.

The lesson of such a group, even if we do not attempt to claim any hard and fast rules or laws from it, is obvious. Matings in which both parents are clearly abnormal, in one case insane or markedly psycho-

[1] The Right to Marry, The Survey, June 3, 1916.

pathic, are to be avoided, and the public should be impressed with the fact that even the mating between such individuals and persons markedly tainted, involves considerable danger, whereas the mating of a tainted or psychopathic individual with a member from a normal stock, involves correspondingly less danger. The somewhat crude idea of legislation, partly in the form of sterilization or prohibition of marriage, should be regarded with suspicion, except in the most glaring cases. In the first place, we must not overlook the fact that in every case in which such legislation has been passed, no adequate provisions were made or, for that matter, could be made for carrying it out, for we must admit that our knowledge on which to base the execution of such laws is not sufficient. This is especially the case as regards the question of determining the importance and significance of various degrees of abnormality. In the second place, we must never forget that psychopathic tendencies, when they have been properly managed, have, after all, furnished much in our civilization that is of distinct value, and that we would not like to miss. We only would have to imagine what would happen to progress, more particularly in the way of altruistic or artistic endeavors, if all psychopathic traits were left out, to appreciate what a wholesale stamping out of these traits would mean. After all, we cannot and should not try to settle everything by legislation, but we have, rather, to develop a better public conscience in regard to the great responsibility of marriage and parenthood.

There is a justifiable discussion as to the relative importance of heredity on the one, and the importance of the influences by which the growing child is surrounded on the other hand; but when we come to deal no longer with potential but with existing individuals, it does not matter to which of these factors we are inclined to give more weight; we must, in order to accomplish anything, be one-sided, in the sense that we put our whole emphasis on training and environmental influences, and this for the present must be an insistence upon proper mental hygiene in the restricted sense of the term. In order to be clear at what hygienic mental training must aim, it is important to be fully impressed first with the fact that life demands constant adaptations, as well as adjustments, between our more individualistic, instinctive tendencies and the requirements of society; and secondly with the fact that most mal-adjustments and bad mental habits are formed early in life. We shall therefore lay most stress upon childhood.

Considering the present state of our knowledge and the lack of organization of it, we shall, as has already been stated, not be able to give in the following anything but a very imperfect account of certain principles, and shall have to confine ourselves to hints here and there about some issues in regard to which the physician who studies the lives of his patients finds that mistakes have most often been made. We certainly would not claim for these remarks anything like completeness.

MENTAL TRAINING IN INFANCY.

A widespread misconception is that we need not think of proper mental training in the infant. But what has just been stated shows that this cannot be begun too early. Undoubtedly the trouble often lies in the fact that the parents themselves are not well balanced and much that is laid at the door of heredity is in part the result of imitation of bad self-management that the child witnesses in the adults of its environment. It is a difficult question for the physician to settle in a given case, whether a child or even an infant should be removed from plainly psychopathic parents, and yet there is no doubt that there are cases in which this would be the only safe course if we could be sure that then we really improved the environment. But there are many, even neurotic, parents who can be taught and who would be willing to do what is right if they but had enough information.

Even in the infant a certain regularity of habits is essential, not only from a physical point of view but from a mental as well, and this largely because it supports any attempts at training of self-control. The most important specific situations in which there is a demand for such training are those first reactions of evasion and shrinking so common in the infant as well as the older child, through which it tries to force others to yield to its impulses of the moment. It must be made clear, therefore, to the child that crying, tantrums, and the like, will not accomplish anything. This will undoubtedly often make considerable demands on the resourcefulness, as well as on the self-control of parents. Also even early in life much petting and caressing is very apt to prepare the child badly for life, not only because it cannot help but emphasize too much a certain erotic tendency, which in its undeveloped form is naturally present in the child, since the sexual instinct does not arise de novo at puberty, but also because it is opposed to the necessary requirement that the child must learn to adapt to a life of hard reality. The neurosis of the single child is too well known not to stand as a warning in this respect. Love for the child is best shown, and in the end best appreciated, in constant thoughtfulness for its welfare and wise guidance, and this of course need not be clothed in an unbending sternness. In fact too much sternness and harshness is quite likely to create in the child a lifelong false attitude which often determines, consciously or unconsciously, an antagonism against any authority, and since most people have to be "under" somebody, and since we all have to subordinate our egotistic wishes to the social good, it is obvious how much trouble this may and actually does create. It is also apt to bring about a lack of frankness which, in addition to other results, certainly tends to block all attempts at sensible guidance. In the same way it is essential that the child be not too much shielded from unpleasant sensations, but learn to bear pain and discomfort without constantly being treated as if this were something which did not belong to the ordinary run of life. Quite

important in this as well as in other respects is the contact with others on the same level as the child, *i. e.*, with other children. They are often the best educators; but they may also do harm, and the choice of the right type is one of the important duties of the parent. Here we should be guided not merely by social convention, which from the point of view of mental hygiene appear often enough silly, or by the pocketbook of the father, but by real character traits.

It is often stated that it is necessary to teach the child to control his emotions. This is good advice in so far as those emotions are concerned which we might call destructive, or at any rate those which get the child out of contact with the environment, *e. g.*, anger and envy. It is, however, not wise to make the child merely suppress such feelings; the reactions should be changed fundamentally. In general, a puritanical stamping out of the visible signs of emotion is likely to make the child emotionally dwarfed and unnatural. It must, moreover, not be forgotten that the emotions are precisely those reactions which bring about the natural contact with the environment and which are therefore helpful. And there are many emotional reactions which in other ways are thoroughly constructive in the sense that they will furnish in later life important sources of satisfaction and thus become balancing factors which greatly facilitate adaptation. The enthusiasm for the good and beautiful, the healthy exurberant joy in play and in success, for example, those we have every reason, from the point of view of mental hygiene, to encourage.

The psychiatrist knows well certain dangers of day-dreaming, yet we must also be aware of the fact that many of the best thoughts and actions in the adult have their inception in that realm and only receive their final practical shaping by the modifying and pruning process exerted by a good sense of reality. Hence a certain amount of day dreaming, like play, is a natural function. It is necessary, therefore, that day-dreaming, rather than be suppressed, be supervised and held in check by seeing that beside it there develops a good appreciation for the concrete and its value and a sound respect for the truth. But we need not oppose a child's enjoyment of and belief in symbols, because after all we cannot express everything in life in scientific terms, indeed some of what is best and most elevating belongs in the class of these imponderables. There is therefore no objection to the belief in Santa Claus, and the like, nor to the enjoyment of good fairy tales. They, too, do represent truth and make life richer.

Harm undoubtedly can also be done to the children by forcing them into appearing something which is beyond them. This is true not only in regard to pushing them in their studies beyond their capacity, but also in making them profess something which they do not feel. It should be appreciated, for example, that children have not the same interests which adults have, nor are their altruistic feelings developed to the same degree. To force them into wrong attitudes in this respect is certainly not likely to create a wholesome frankness.

TRAINING OF OLDER CHILDREN.

Especially in the older children we must not be deceived by so-called model behavior, which may be associated with shunning intercourse with other children or the actual doing of things with others, in place of which we find undue occupation with books and with subjects which are fit only for older periods of life. These traits, therefore, often represent a defect rather than an advantage, no matter how much they may please the parents. They are doubly dangerous because they hide behind an exterior of apparent excellency a desire to shirk the real adaptation to life and are apt to throw the child back upon himself and foster what we might call a malignant day-dreaming that leads more and more away from contact with reality. It also is hardly enough appreciated, especially by nervous parents, that the child must have a certain freedom and possibility to shape his life, under proper guidance. Some neurotic children are only too likely to desire a certain domination, which must not be yielded to, and many nervous invalids suffer later because they never were trained to depend upon themselves. Quite important is it also that the child develop proper standards of conduct. We do not refer in this so much to moral standards, which of course are important but are more generally appreciated, but rather that care be taken not to foster false ambitions. Behind much of the sensitiveness that we see in children and adults there are false ambitions and false attitudes toward what one has a right to expect from the world, which require most careful investigation, explanations, and more than anything else, good examples on the part of the environment. Any one who has the important duty to guide a child must, above all, have worked with himself and have attained a certain clearness about his own personal attitudes and motives. In general, we must remember that the bringing up should be essentially a training in adaptation to life, with its various knocks and disappointments, as well as its fortunes and successes.

A serious mistake which is often made is that people are not sufficiently impressed with abnormal traits. Many people are likely to look upon caprices, fads, ill-balanced desires, above all, moods, and the like, from the point of view that they are "just natural," or that "any child might have them." But one of the most important pieces of advice we can give is that we must appreciate that they are traits which should be investigated, often not without the help of a competent physician who is capable of studying and understanding the meaning of such traits. Here also should be mentioned a host of so-called physical symptoms, such as frequent headaches, digestive disturbances, bed-wetting, and the like. A neurotic tendency should always be suspected behind these, and a physician should determine whether there is a physical basis or whether these tendencies represent wholly or in part psychopathic traits, and should therefore be objects of mental treatment.

THE SCHOOL AND MENTAL HYGIENE.

A word should be said about the school. If the essential of the education is character formation, not only from its moral but also from its hygienic aspect, it is obviously one-sided that the school still lays stress only on the acquisition of knowledge. It is surely not the wish of psychiatrists to neglect this, but the school too should recognize —and I do not hesitate to repeat this at the danger of becoming monotonous—that the chief task of life is adaptation and that whoever has a hand in the shaping of the child's mind and mental habits should recognize that this must not be neglected. This can, perhaps, hardly be included in a curriculum of the school; but it must be expressed in the spirit of the teacher and the school in general and should be supported by well-trained school physicians and clinics in connection with the schools. It will be a long time before such tendencies will have an adequate footing in our schools, and yet if we but followed the teachings of Pestalozzi and the most enlightened educators, and supplemented this, as I have said, by capable physicians trained in the study of mental abnormalities, so that, when slight danger signals arise, they would be the objects of investigation and treatment rather than punishment or neglect, much would be accomplished. A school should be judged not only by the examination records but also by the kind of individuals it turns out.

MENTAL TRAINING AT PUBERTY.

Puberty is the period in which essentially two features enter into the life of the growing human being—the beginning of the loosening of home ties and the sexual longings. The purpose of these is preparation for stepping out into life as a self-reliant being, and for the fulfilling of the biological demand for the propagation of the race which is connected with the sexual instinct and accomplished by the looking for and the finding of a mate. How often do we pay attention to the struggles which are associated with these important demands for adaptation! That the period runs smoothly enough in many normal individuals is true; on the other hand we also know that it is the most important period at which the manifestations of neuroses or psychoses begin first to show themselves. We should recognize a natural desire for some freedom from home ties in the boy or girl approaching adolescence, rather than through selfish motives keep them dependent, as is too often the case by well-meaning but morbidly anxious or poorly informed parents. That this does not mean an abandoning of the growing child to its own devices and unbridled longings, I hope is sufficiently emphasized by the general spirit of this chapter.

Then as to the sexual instinct. There is no doubt that, among those who advise the child, more frankness should exist and more of a sensible, sympathetic attitude, so that the desire for advice, present often enough, but, since it concerns such personal matters, so easily thwarted,

is encouraged rather than repelled. Every psychiatrist who has carefully studied the lives of his patients knows how rarely such a desire is encouraged, partly through thoughtlessness and lack of appreciation of the real difficulties, partly because these matters have never been properly dealt with by the would-be advisers themselves.

This naturally leads to the question of masturbation. My experience as physician has been that masturbation is usually treated with too much horror and too much mystery. It must not be forgotten that a certain amount of masturbation is very common and often does no harm; and it is not correct to say that masturbation causes insanity. The habit is often a symptom of a mental make-up characterized by seclusiveness, and out of this a mental breakdown not infrequently develops. For the rest, excessive masturbation is likely to bring about certain nervous conditions, but most often the greatest harm comes from the fact that the boys or girls have been scared into believing that by yielding to their auto-erotic impulses they have made outcasts of themselves or injured themselves for life. This naturally is not conducive to a development of a good contact with the outside world which is so essential. Here as in all that concerns the sexual instinct, a pure and open attitude which leads to explanations and warnings on the basis of what is decent, dignified and healthy, is most important. It is hard to tell which is worse, a frivolous attitude or one of horrified condemnation. I dare say both are equally bad and equally far removed from a natural way of dealing with the situation. I should not advocate sex instruction in school. These are matters which are best left to the parents or whoever has a more personal charge of the child or to the family physician, and we should be guided by the initiative of the child. This, however, can be done only if the spirit of openness above alluded to has been thoroughly developed.

MENTAL HYGIENE IN THE ADULT.

In regard to the general mental hygiene of the adult the most important advice here again seems to the writer to be that every one should develop a more alert attitude toward abnormal traits, not only educators and parents in regard to the children, but every one in regard to himself. It has sometimes been stated that psychiatrists are apt to see too much abnormality. This is, of course, an absurdity. But psychiatrists are convinced that much would be improved if people, once for all, would get a clear appreciation that many traits are abnormal, or at any rate require handling, such as unfounded suspicions or anxieties, ill-balanced enthusiasms, sudden mood changes without adequate reason, uncalled-for feelings of being at a disadvantage, feelings of inferiority, morbid indecision, tendency to too ready despair, peculiar warped mental attitudes, a lack of desire for natural intercourse with fellowmen, and many more. The public should also know that not only the more glaring hysterical ailments which simulate physical diseases but also many milder symptoms, such as headaches,

digestive disorders, various pains, etc., may have a purely psychopathic and not a physical basis, and that they, like the rest of the symptoms above enumerated, represent signals of danger of a breaking down of mental balance. It is, of course, not meant that all such signs denote that a person will become insane. We know that this is not the case, since these traits often represent merely a temporary disorder under a special stress, or a condition which, with ups and downs, never leads to any graver disorder, but even if it does not bring about more serious results, we should remember how much energy is expended in the struggles of such people and is taken from useful activities, how much trouble such traits make in the world and what hardships they may impose on others. Even in physical hygiene the public mind is not sufficiently instructed, and we are far from being convinced that health is a duty as much as moral conduct. Indeed health is the most fundamental ethical duty. A well-known leader in American medicine once said that public health would be greatly improved if everybody had the feeling of responsibility toward health which the best informed physicians have. This is precisely what I wish to apply to our problems of mental health. Maeterlinck in his "Wisdom and Destiny" has fully appreciated that we are for the most part responsible for what happens to us, *i. e.*, for our destiny, and with wonderful insight has written much that is excellent mental hygiene and which should be widely read. Every physician should, therefore, be acquainted with the danger signals of breaking down mental balance, indeed every one should make it a business to train himself to a greater keenness in appreciating neurotic tendencies, wrong mental habits, unhealthy attitudes, etc. Now it is undoubtedly true that, in order to be able to be clear about one's own motives, knowledge is required, more particularly knowledge of the deeper forces which actuate us, for many of our real motives are hidden from us. The modern psychoanalytic teaching undoubtedly furnishes us with knowledge of these hidden forces and gives much important information. Anything which helps toward a formulation of our motives is valuable, even if this formulation is only partly correct, because this helps us to manage them. But if, as is natural in a new science, there is a certain one-sidedness, and there are many formulations which in their present form are not broad enough, the writer nevertheless feels that, approached with an open mind and looked upon as a matter which is still tentative, a study of psychoanalysis can be useful only if the person who occupies himself with it is wise enough not to be taken in too much, either in a positive sense of being too much swayed by one-sided conclusions, or in the negative sense of being repelled by certain features so that he turns his back on the whole teaching. But without that, much more can be accomplished, even with more conscious motives, than is commonly done if every one had the conviction that we are, to a certain extent, responsible for our neurotic symptoms as illustrated above. The scientific determinism of the will has its place in philosophy; the practical man will say to himself that there is plenty of self-determi-

nation which he has no right to shirk, and that there is a healthy habit of working with oneself, which must not be confounded with a morbid introspection which, because it fusses about non-essentials and matters which do not go to the root, is unproductive and works harm. And if a person is incapable of handling the situation himself he should appreciate that he is dealing with a health question quite in the same way as in the case of any physical ailment in which a properly qualified physician should be consulted. A more widespread appreciation of how much is really psychopathic is likely to create also a better and franker attitude about such matters and do away with the absurd horror of all that savors of the mentally abnormal and which undoubtedly is responsible for the dangerous lack of honesty in this respect.

It is also important to remember the fact that in order to keep up our mental balance we need a certain amount of satisfaction, just as we need food in order to keep up our body. This is an important consideration for the shaping of one's life. In this respect we must constantly keep in mind that we have to arrange our activities so that they harmonize with our capacity. This may require a reshaping of our ambitions and a straightening out of false attitudes. Every psychiatrist knows how much that is neurotic arises from such false attitudes and that they cannot be changed in a day. One of the most stable satisfactions is derived from a duty well done, and we are all surrounded with such duties, be it in our chosen work, or in needs which surround us and which call for service. Putnam says very justly that the more fully a person tries to give expression to his whole self (obviously a great health problem) the more fully he lives outside of himself. Work is certainly one of the greatest blessings that humanity has, and to train one's self to satisfaction in even simple but concrete accomplishments is undoubtedly an important rule of mental health.

But here should also be mentioned all those balancing factors which come to us from intellectual pleasures, sensible hobbies, and above all esthetic pursuits, such as music and art in general. The richer we can make life in stable satisfaction, the more we shall be able to weather difficult situations. It is important to grasp fully the value of such balancing factors and the necessity of a certain multiplicity of them, so that we do not have all the eggs in one basket. This is especially true in women who often have a life that is less rich than that of men. How many a mother has seriously broken down over a death or other change in her family because her life was too narrow. It is also a matter which may well be remembered by men who give up their occupations in later years. If the latter constituted the essential satisfaction upon which they lived, they cannot expect to retain their nervous balance when they are suddenly deprived of it.

THE MARITAL STATE AND MENTAL HYGIENE.

We should not omit mentioning the great demands upon adaptation which married life makes. To make ourselves appreciate fully the

importance of this subject, we have only to remember the large amount of disharmony which exists in this situation and the fact known only too well to the psychiatrist that many persons break down with neuroses or psychoses under the strain because it is not properly managed. Some persons undoubtedly are not fit to marry, and here a word should be said about the advice to marry, which is so often given even by physicians to neurotic individuals. The idea behind it seems to be that marriage creates a sexual outlet and furnishes many other satisfactions by giving a content to life which did not exist before. The latter is undoubtedly true if the person is adequately prepared for it. As to the sexual outlet it must not be forgotten that the sexual instinct is not a simple matter like hunger, a satisfaction of which is healthy in moderate degree, and unhealthy in excess, but it is an instinct which is involved in our whole development and therefore extremely complex. And yet general rules about who should and who should not marry cannot be given and every case should be decided on its own merits. But it must also be clearly understood that the widespread *disharmony in married life* is *neurotic* and not necessary. Here, above all, it is important not to muddle along, but to attempt to get clearness about the direction in which one is going and the motives which actuate one. There are, of course, cases where divorce may be the only salvation, very often much can be done by a thorough appreciation that both partners are dealing with a demand for adaptation created by the fact that they live in close contact with another personality which has its own inclinations and its own will, and that subordination of many wishes is therefore required. Sometimes a competent psychiatrist must be consulted, for it is just as well to understand that such a disharmony is a health problem which may be too difficult to manage alone.

GENERAL MEASURES IN MENTAL HYGIENE.

There are some general measures which should not be forgotten in this brief account of what mental hygiene, even at this imperfect stage, should aim at. In the first place, it is quite obvious that those who should be most concerned with this as well as all other health problems, are the physicians. If they have woefully failed in this task, however, not much blame can fall upon them, so long as the medical schools neglect this branch of medicine almost entirely. There are, to be sure, some family physicians who are natural born practical psychologists and have enough conviction not to yield to prevalent medical habits; they do not forget that a human being may have internal struggles and tribulations and that much impairment of health and much "nervousness" can be removed only by entering into these and by modifying the patient's life. But the average physician shuts his eyes to all that is mental and regards everything as physical. This would have a certain justification if we had a full knowledge of the physical defects which underlie difficulties of adaptation and could handle them from that point of view. This is obviously not the case,

and even if we knew much more than we do there would still be the bad mental habits which, after thorough investigation of their nature, demand retraining on the basis of this knowledge. The result is that the entire field has passed from the physician into other hands and has led to wholesale would-be management on the basis of fads. This will never improve until, as we have said, psychiatry has become an important part of medical education and until those who teach psychiatry have better facilities for teaching than are now generally available. It is not the men who deal with the insane only who should teach psychiatry, but men who have opportunities in psychiatric clinics in which insane cases, as well as milder mental abnormalities, *i. e.*, every conceivable form of "nervousness" or abnormal conduct, are treated both in the clinic and in adjoining dispensaries and in which the guiding spirit can be made the dealing with mental abnormalities in this wider aspect of a public health problem. We are at present witnessing in the public at large an awakening of the recognition that mental abnormalities do represent an important public health problem, yet for the very reason that the facilities above mentioned are not available we constantly find that we have in reality not enough physicians who can adequately handle the problems.

THE ROLE OF DISPENSARIES IN MENTAL HYGIENE.

In regard to other public duties in this connection I may say that undoubtedly the increasing attention to bodily hygiene and the gradual improvement in the standard of living will help in preventing mental disorders. But we must also keep in mind more specific duties, and, since intelligence and education are required to accomplish anything in personal mental hygiene, we should mention here some measures qualified to help the more uneducated classes. Dispensaries for mental abnormalities, even the relatively few that exist, are at present still visited too much by persons who in reality come too late because they are too far advanced; but such dispensaries have undoubtedly an important future as places in which the poor people who have "nervous" troubles should be able to obtain advice. Since any advice may be futile without efficient help to the patient in reconstructing his life, such places will always fail in their function, however, unless they have associated with them a competent social service department. And there is no doubt that we shall some time see the advent of public sanatoria for "nervous" cases, *i. e.*, for cases whose trouble, though made of the same stuff as insanity, need not have applied to them that legal term and who are still in a stage when a more serious breakdown can be avoided. In this connection should also be mentioned a valuable suggestion made by Adolf Meyer.[1] He makes the point that we are much in need of better standards in com-

[1] Where Should We Attack the Problem of Prevention of Mental Defect and Mental Diseases? No. 53, Reprints of Addresses of the National Conference of Charities and Correction, 1915 Meeting at Baltimore.

mon ideals of solidarity and urges the formation of groups or districts arising out of the combining of various community activities in which mental hygiene should then also have its part, a suggestion which, if carried out in the manner which he details in his paper, would undoubtedly be as valuable as it would be practical if the necessary spirit can be created.

THE TREATMENT OF THE INSANE.

But we also need better provisions for the treatment of the insane themselves. The surveys of the National Committee for Mental Hygiene have revealed that often our treatment is still not even uniformly humane, to say nothing of up to date. Let any one read Salmon's "The Insane in a County Poor Farm" to feel the whole shame of what is still done in some parts of this country. Indeed even in the States which have the best provisions there is room for further improvement, which would make more rapid progress if only a widespread sense of public responsibility would take the place of politics. The great cost of the provisions for the insane could undoubtedly be lowered by a systematic development of industries in which many of the chronic patients could take part unquestionably to their own benefit. Among the inadequate provisions for the insane a very important part is the dealing with patients before they enter the hospitals. In the first place, our very system of commitment in its various forms is based on a wrong conception. There will undoubtedly be a time when people will look back, as to a barbarity, to the fact that legal proceedings had at one time to be gone through to get a sick man into a hospital for treatment, and now that it exists it undoubtedly adds to the horror of the situation. The matter could be handled much better in a medical spirit. Even now there exist ample provisions for appeal to courts and for official supervision of detention, so that it is unnecessary to burden every one who has the misfortune to have a mental breakdown with a legal or police encumbrance. Then, again, how many communities have adequate provisions so that a person with a mental breakdown can at once humanely be dealt with, instead of being taken to prisons and lockups? Here the measures advocated by William L. Russel of having the health officers look after this part and his recommendation that each community should make satisfactory hospital provisions for such cases are the only solution if properly carried out. In this respect general hospitals could do a great deal by having wards for mental cases. It is interesting that formerly this used to be the case, and there is no doubt that the custom will return in the form of wards for first treatment or for mild cases.

Crimes and misdemeanors may often be the result of mental abnormalities. It is therefore natural that persons arrested or imprisoned may be objects much more for treatment by a physician than for handling by prison authorities. The gradual transformation of prisons into treatment stations will naturally have to be a matter of slow

and safe development, but even aside from this general problem abnormal conduct which conflicts with the law may often be plainly the result of a well-known mental abnormality, for the discovery of which provisions should be made. It is therefore a distinct advance in mental hygiene that a beginning has been made to have adequately trained psychiatrists available for consultation in prisons, juvenile courts, reformatories, and in connection with police headquarters. There is no doubt that in these various fields we have been and still are guilty of much mismanagement.

THE ROLE OF IMMIGRATION IN MENTAL HYGIENE.

In a country like America with, in normal times, a constant influx of an alien population who will be the future citizens, it is natural that immigration represents a great problem of national mental health. Therefore this should not be omitted in our present considerations. In dealing briefly with this question I cannot do better than follow Salmon,[1] who has made a more thorough study of the subject than any one else. He says that it can be "earnestly asserted, after long study of this question, that no measures for the control of mental diseases and mental deficiency which have yet been suggested can prove so efficacious as artificial selection of additions to our population on the vast scale which an adequate mental examination of immigrants would permit. This is a measure of practical eugenics which can be applied successfully now and one in which we shall not have to wait a generation to note the effect." Surely if this could be thoroughly appreciated by every one who has at heart the question of our national mental health—and what thinking American does not—the country certainly would embark much more determinately on this absolutely legitimate process of adequately selecting "the parents of future generations of Americans."

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CHAPTER XXIX.

MENTAL DEFECTIVES. PREVENTING AND CONTROLLING MEASURES.

By HENRY H. GODDARD, Ph.D.

The recognition and understanding of mental defectives is among the very important problems that confront the health officer. It is now generally agreed that upward of 2 per cent. of juveniles are so defective mentally as to be incapable of self-support and self-direction and are largely irresponsible.

Because of their lack of self-control mental defectives are a menace to society and unless recognized and cared for they go from bad to worse, swelling the ranks of the drunkards, prostitutes, criminals and ne'er-do-wells. A still greater percentage are defective to a milder degree, but sufficiently so to cause them to fall into delinquencies of various kinds, thus often rendering them perplexing problems to those who do not recognize their condition.

Whoever will take the trouble to understand and learn to recognize the high grade mental defective will find himself master of many a problem that has proved baffling to those who have not this knowledge. There are thousands of cases of unrecognized feeble-mindedness complicating our social and industrial problems.

The high grade defective or moron is the most troublesome, partly because he is not easily recognized as defective and partly because he has sufficient mentality to go about by himself and get into all kinds of mischief either on his own account or led on by someone else. The mischief of his own originating is usually very simple action though it may have serious consequences. He may steal but cannot plan a robbery. He may lie but not consistently. He will follow his impulses, and this will often result in the destruction of property. He may set fire and sometimes become a regular "fire-bug." Under the direction of an intelligent criminal he may execute a robbery or commit murder; under the direction of a good citizen the same defective may be a useful worker to the limit of his mentality, and a pleasant, agreeable and harmless person, though always with the mind of a child. The *always* must be emphasized. There is no known cure for the condition, and while, as above indicated, he may be trained to moderate usefulness and away from crime and misdemeanors, yet *he is always a child.*

As to the recognition, aside from the idiot and low grade imbecile, there are only two or three types that are recognizable at sight.

The hydrocephalic or large-headed person is usually though not always defective. At least the condition is enough to put the burden

of proof on the other side, *i. e.*, one must convince oneself that a hydrocephalic is *not* feeble-minded before accepting him as normal.

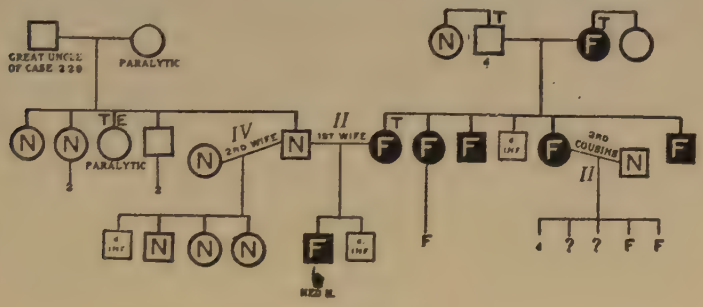

FIG. 106

FIG. 107

FIGS. 106 and 107.—Family history charts, showing hereditary feeble-mindedness.

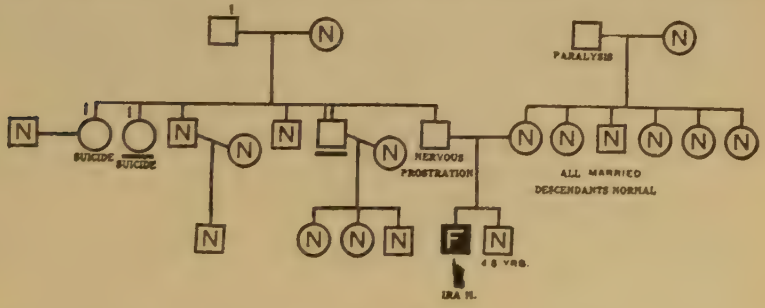

FIG. 108

FIGS. 106, 107 and 108.—Charts showing neuropathic ancestry. Squares, males; circles, females; *N*, normal mentality; *F*, feeble-minded; — under a symbol, in an institution; *T*, tuberculous; *E*, epileptic; *D*, deaf; *I*, insane; *d*, dead; *d*, inf., died in infancy; horizontal line connecting a square and a circle, married; short vertical line connected by horizontal shows children of parents of parents above. (From Feeble-mindedness, Its Causes and Consequences, Courtesy of Macmillan & Co.)

The microcephalic or small-headed person is practically always defective to a degree roughly proportional to the smallness of the head. A circumference of twenty inches has sometimes been given as the

dividing line between microcephaly and normal-headedness; but of course no sharp line can be drawn.

The one type that is definite and that should be recognized by every physician is the so-called Mongolian. This has no connection with the Mongolian races except a more or less marked resemblance to that type of countenance, especially, in a thoroughly typical case, the obliquely set eyes. The following description from Shuttleworth will enable the physician to recognize the type, and once it is seen it is not easily mistaken:

"In these cases the skull is a short oval, the transverse and longitudinal diameters approximating, while there is a tendency to parallelism of the frontal and occipital planes. Children of this type have a skin coarse in epidermis, if not furfuraceous; many have sore eyelids, some fissured lips; but one of the most striking peculiarities is the state of the tongue, which is transversely fissured, and has hypertrophied papillæ. Dr. John Thomson states that in the early weeks of life the tongue is normal; between the third and ninth months the papillæ get enlarged, while during the third and fourth years the transverse fissures appear. This latter peculiarity is possibly due to tongue-sucking, which is so common in this type of defective, acting on an abnormally vulnerable mucous membrane. Many of them have almond-shaped eyes, obliquely set, and this feature, with the squat nose, epicanthic fold, and wiry hair, gives the mongol aspect from which they derive their name. The hands are usually broad and the fingers short, and often the little finger is incurved. The feet also are characteristically clumsy, with a marked cleft between the big toe and the next one. Laxity of the joints is a marked feature. There is reason to believe that they are essentially *unfinished* children, and that their peculiar appearance is really that of a phase of fetal life."

It should be stated that the fissured tongue is not always present and one should not be in doubt about the diagnosis because of the absence of this feature. On the other hand its presence is determinative in otherwise doubtful cases.

Mongolianism can usually be diagnosed early, age six or eight months, and sometimes even earlier. This should always be done *for the sake of the parents.* A diagnosis of Mongolianism settles several points: (1) The condition is not hereditary. (2) It is more frequent in the better families. (3) The child will never develop beyond about seven-year mentality and the great majority have a mentality of almost exactly four years. Consequently (4) they must always be cared for. Unpleasant as the duty is, yet in the long run it is a kindness to the parents to inform them of such a diagnosis.

It has long been customary to regard the easily recognizable idiots and imbeciles as constituting a group apart from normal persons and as requiring special consideration. Only recently has it been appreciated that there is a large group not so easily recognizable, but, nevertheless, whose conduct is explainable on the basis of mental deficiency. Mental defectives are generally regarded as cases of

arrested mental development. The phrase implies what is now understood as a fact, that the mind develops from birth to adult life much as the body develops; and just as the body may stop in its development, giving rise to the dwarf, so the mind stops, giving rise to the mental defective.

It is customary to divide these defectives into groups according to the amount of mental development they have attained. Those who have the mentality of a two-year-old child or less are called *idiots*. Those of a mentality of from three to seven, are called *imbeciles*, while those who have attained to the mentality of a normal child of from eight to twelve, or perhaps to the beginning of puberty, are known as *morons*. Each of these classes may be divided into low, middle and high grade. In addition to these we have a group that are above the moron in mentality but whose conduct shows that they are not thoroughly normal; for these no satisfactory term has been discovered. They are sometimes called *dull normal*, or *backward*.

Obviously a person cannot be assigned to any one of these groups until it is ascertained that his development has actually ceased. A five-year-old child with five-year mentality is not an imbecile, because the assumption is that he will continue developing at the normal rate. Even if he has only the mentality of four or perhaps three, we cannot conclude that he is an imbecile because, while he is clearly below normal, there is a possibility that he may continue to develop, becoming at least a moron, and possibly dull normal or even average normal. Consequently the first problem for anyone who would deal with mental defectives is to ascertain as accurately as possible whether the person has already stopped developing. There is no known way of determining this in every case, but we have some empirical formulas that enable us to diagnose cases with all degrees of certainty from a mild suspicion up to practically complete assurance.

Alfred Binet, who first suggested that it was possible to take the mental measure of such cases, and himself gave us a measuring scale for intelligence, deduced from his experience this somewhat crude formula: *Children who are under nine years of age and show a backwardness of more than two years, are probably mental defectives to the extent of being actually feeble-minded; those who are nine years or more and show a backwardness of more than three years are also feeble-minded.*

Experience has proved that as a rule Binet's formulas are well within the truth. Since his time, however, more accurate methods have been devised and we now use what is known as the Intelligence Quotient (called I. Q.). This is obtained by dividing the *mental* age, as it is called, by the chronological age, which of course gives, in the case of backward children, a fraction. If that fraction is less than 0.75 there is a very high degree of certainty that the person is feeble-minded. If the fraction is greater than 0.80 the person, while backward or dull normal, is not feeble-minded. If the Intelligence Quotient proves to be between 0.75 and 0.80, the case may be a doubtful one and is frequently called "border-line." It will be seen that Binet's formula

as far as it goes agrees with this result. A child under nine, let us say eight, who is two years backward, having a mentality of six would have an I. Q. of six divided by eight, or 0.75. If more than two years backward, his I. Q. would be less than 0.75 and he would therefore be defective. A person who was nine with a mentality of seven would have an I. Q. of seven divided by nine, or 0.77 and is therefore just above the danger line. With a backwardness of three years, however, he would have an I. Q. of 0.66, which is well within the feeble-minded limits. The advantage of this formula is shown when we come to the lower or the higher years. A child of four, for instance, with a mentality of three would have an I. Q. of 0.75 and thus be a suspicious or border-line case. While with a mentality of two and a half he would be distinctly feeble-minded. On the other hand a child of twelve who tested nine would be still a border-line case although fully three years backward.

It is obvious that for the application of the intelligence quotient formula it is necessary to know the mentality with considerable accuracy, just as it is necessary to use the chronological age with accuracy. It is customary to express the latter in years and tenths of a year and the mental age in the same way. The former is of course easily determined if we know the birth date. It is well to sound a word of warning here, however, because ofttimes parents either do not know the birthday accurately or have falsified it; as for instance, making the child older than he is so that he can get out of school and get his working papers sooner; or on the other hand making him younger, because they perceive his backwardness, and, being somewhat ashamed of it, wish to make out that he is not much behind his age.

The mentality, "mental age" or "mental level," is now determined by some system of psychological tests. The best known of these is the Binet-Simon Measuring Scale for Intelligence, which, when carefully applied under favorable conditions by an expert psychologist, especially trained for the work, gives the mentality of the person to fifths of a year with a high degree of accuracy. In all doubtful cases, some such psychological examination should be given and the mentality determined with as great accuracy as possible. However, it is often desirable to approximate the mental age when the facilities for making a psychological examination are not at hand. It is usually possible to do this and the results are often sufficient for practical purposes. For instance, if a child of twelve seems to have a mentality of approximately six, he is obviously so definitely feeble-minded that a more accurate measure of his mentality is not necessary for the immediate purpose, though desirable for guidance in training. For unless one has made an error of at least three years, there is no possibility of the child's being normal.

There are several facts of easy determination that contribute to this approximate estimate of mentality. First is the school history. Careful studies have shown beyond question that school progress is a fairly accurate measure of intellectual progress. Most children enter school at six and advance a grade a year. This means that first-

grade work practically measures six-year intelligence; second-grade work, seven year; third-grade work, eight year; and so on. One has

FIG. 109.—Twelve years, mentally seven.

FIG. 110.—Eleven years, mentally six.

FIG. 111.—Twenty-six years, mentally ten.

FIG. 112.—Twenty-five years, mentally seven.

then only to ascertain what grade of work a child is doing in school to know whether he is doing the work that is proper for his age or whether he is backward. For example, a ten-year-old child should be doing fifth or at least fourth-grade work. If he is doing only third grade, he is decidedly backward; if only second, he is probably feeble-minded; if only first, he is surely so, provided of course he has been to school. Too much allowance, however, must not be made even for this lack. A ten-year-old boy who has just entered school may possibly be in the first grade, although even that is rather unlikely if he is normal, but if so, he will be doing his work with an intelligence and progress that will enable the teacher to say without question that he is a normal boy. On the other hand, if the teacher's report is that he has difficulty with this first-grade work, one may be extremely suspicious to say the least; and it often happens that a child has not gone to school because of his deficiency, which is more or less recognized at home.

Another criterion of considerable value, when an accurate determination cannot be made, is the child's social reaction. If he has lived among other children, what grade or age of child does he prefer to play with? It is found that as a rule children prefer to associate with children of their own mentality rather than with children of their chronological age or even their physical size; so that if a child of ten prefers to play with children of six, it is very suspicious. Under this head may also be included the child's conduct, both social and moral. Does he act, talk, like a six-year-old child? Is he given to the moral conduct natural to a child younger than he is?

Again, the physical examination will sometimes show more or less obscure stigmata of degeneration, of infantile conditions of one kind or another, and while these may no more than raise a suspicion, they are nevertheless often helpful especially when taken with the other criteria. Family history in many cases is exceedingly valuable. For example, if it is found that the child has brothers and sisters that are known to be feeble-minded, or if the parents, one or both, are recognized as low grade or degenerate, or if even more distant relatives are of this character, this lends a fair presumption that the child at least *may be* defective.

What has been called practical knowledge is also of considerable worth in getting at this approximation of the mentality. To what extent does he know the things in his immediate environment which he might reasonably be expected to know? With younger children this is more difficult because most of us do not know just what children of the various ages notice in their environment. With older persons, however, it often becomes a very significant sign, when it is found that the individual has not noticed and learned about the common things around him.

With older persons the industrial history is significant. The amount earned is not always significant, partly because some of these high grade morons earn a very fair wage, and partly because it is difficult to ascertain just what the wage has been. If the person has ever by

accident earned a good wage or secured a job that paid a good wage even if he kept it only for a day, he will claim that he has earned so

FIG. 113.—Twenty-five years, mentally nine.

FIG. 114.—Sixteen years, mentally ten.

FIG. 115.—Seventeen years, mentally ten.

FIG. 116.—Twenty-five years, mentally nine.

much. Along with this, however, and much more significant ofttimes, is the kind of work that he has done and the length of time that he can

hold a job. Some morons, it is true, are quiet and docile and patient and retain a job fairly well. But as a rule these people do not stay long on the same work. Lacking self-control, judgment and good sense, they are very apt to get discharged for failure to satisfy the employer and are quite as likely to throw up the job because of some real or imaginary difficulty or slight or offense, or because they hear of a job somewhere else.

The case histories at end of chapter will illustrate this last point sufficiently.

Another helpful line of investigation has to do with the cause of the condition. That is to say, in a case of suspected feeble-mindedness if there is any known reason why the person should be feeble-minded it offers some presumption that he is so. If on the other hand there is no known reason, this offers an equally good presumption against it. It will of course be appreciated that the presumption is not great in either case and is of no value except in connection with other facts. We have already alluded to the family history as possibly showing other defectives in the family. This would come under the head of "cause" since it is now known that a large percentage, about 66 per cent., of feeble-mindedness is inherited. There is also quite a percentage of cases where, although there are no other feeble-minded in the family, there are a great many instances indicating an unstable nervous condition, which seems somehow to be transmitted to the child in the form of feeble-mindedness.

Then we have diseases. While one can easily imagine that there are many diseases that might affect the brain so as to produce feeble-mindedness, as a matter of actual experience there is practically only one that has a demonstrably bad record and that is cerebrospinal meningitis. If a suspected case has had meningitis there is a rather strong presumption in favor of mental defect. Extremely severe attacks of certain other diseases, such as scarlet fever or malnutrition in early infancy, may also have some significance. On the other hand instrumental delivery does not prove to be a great factor. One needs to know very specifically the actual conditions of delivery in order to make it of any value. Partial strangulation with delayed animation seems to be rather more serious than the ordinary forceps delivery.

Falls, blows on the head and other injuries are very uncertain and again must be described with very specific details so that one can judge rather closely as to the probabilities. When so judged and when compared with experiences of children who grow up to be normal these injuries do not prove to be very frequent factors.

Syphilis and alcoholism in the parents do not seem to cause feeble-mindedness in the children. Recent studies show that syphilis in parents produces psychopathic children who often deteriorate mentally to the feeble-minded level. But they should be carefully distinguished from cases of true *arrest* of development—feeblemindedness.

Consanguinity has *per se* nothing whatever to do with feeble-mindedness. If there is feeble-mindedness or bad nervous condition in the

stock, the bringing together of two branches of that stock doubles the liability of some undesirable condition appearing in the child. But the mere fact that the parents were cousins gives no presumption whatever toward the child's being feeble-minded. It goes without saying that one should not make a snap judgment that a person is or is not feeble-minded on the basis of any one fact or expectation or prejudice or previous notion as to what constitutes feeble-mindedness.

In what follows we have in mind the moron and high grade imbecile, as of most interest and importance to the reader. The idiot is well-known and seldom becomes a public problem, the low grade imbecile is so easily recognized and so obviously irresponsible and a subject for an institution that it is unnecessary to discuss him here. It is with the high grade cases that the medical officer can be most useful both to parents and to the public.

As will be inferred from what has been said, the inexperienced person is most likely to conclude that a particular case is not feeble-minded. A recognition of some further characteristics of high grade mental defectives will help in this particular. It is very common to hear people cite some rather shrewd trick or action of a person and conclude from this that anyone who does such a thing is certainly not mentally defective. The conclusion does not follow. It is a familiar experience to all officers of institutions for the feeble-minded, that there are types of feeble-mindedness that show considerable shrewdness along certain lines. There are boys who can pick locks with great skill; there are many of them who show considerable aptitude along mechanical lines, especially if they have ever had the opportunity of being trained. Sometimes they show remarkable, or what appears to be remarkable, memory. Perhaps most deceptive of all is what we have called the *loquacious type*. There are boys and girls, men and women in years, who have a quite remarkable flow of language and if one does not listen attentively and examine critically their conversation, it is easy to conclude that they are average normal persons. Such critical observation usually discloses the fact either that their talk is mere gibberish or is the repetition of more or less intelligent phrases which have been picked up from the conversation of intelligent persons; a good memory, coming to their aid in such cases, enables them to store up these expressions for use upon occasion. Also some types are rather skilful in covering up their defects and in evading questions put to them to bring out their condition or tending to elicit incriminating admissions. In *The Criminal Imbecile*[1] the writer has described three cases of very high grade feeble-minded persons who had committed murder. All of these were typical high-grade cases and the description of them will help anyone to understand the possibilities of such cases. It may be noted further in speaking of criminals that all of these three confessed the crime. This is on the whole character-

[1] Macmillan, 1915.

istic of defectives. While there are cases that stand out and resist all attempts to induce them to confess, yet as a rule, they seem to be rather proud of the execution of their crime and that pride rather quickly overcomes any fear and desire to escape; so that if carefully handled and their pride appealed to, they are very apt to confess and tell the whole thing in such a way that it is easy to convict. They are as a rule extremely suggestible as would be expected from the fact of their childish mentality.

One thing that is particularly apt to deceive the inexperienced is the physical appearance. It is commonly supposed that a mentally defective person shows his defect readily, either in his physical form or in his movements or in the eye or some such outward expression. This is so often an entire mistake, that it is safest to conclude that there is nothing whatever in it. While it is true that those who have had long experience with the feeble-minded can usually detect them rather quickly, yet it is equally true that there are cases that deceive the very elect. Some of these people are as well formed and present as good an appearance as the average person one meets. While conversation would usually reveal the truth to the trained person, to the untrained, this is often passed over as being due to ignorance, and the person is considered illiterate rather than mentally defective.

The general mental characteristics that can be determined without resort to psychological examination are (1) lack of control of their emotions and impulses, (2) inability to adapt themselves to new conditions, (3) inability to generalize from experiences or to deal with abstractions (4) general lack of good judgment and good sense.

With such characteristics as have been pointed out, it is evident that these persons are a great menace to society. They are incapable of self-control and therefore easily yield to their natural impulses. Having few general ideas and still fewer moral principles, they are easily led astray by others. One of the criminals described in the book already referred to is a marked illustration of suggestion. He had no interest or motive in the murder he committed and did it entirely at the suggestion of an older and more intelligent man. Not only are mental defectives theoretically capable of all kinds of anti-social conduct, but careful studies have now shown us that these groups of criminals or delinquents are quite largely made up of mental defectives. It is believed that a large proportion, perhaps 50 per cent., of the inmates of our reformatories are feeble-minded. Even the adult prisoners in our penitentiaries are mentally defective to a large extent. Of the prostitutes that get caught and come before the court, fully 50 per cent. are thus defective. Similarly with drunkards, hoboes, paupers and ne'er-do-wells. The failure to recognize these people as mentally defective costs the State annually thousands of dollars. They commit misdemeanors and crimes, the court convicts them, sends them to penal institutions for thirty, sixty or ninety days, or even a year or two; they serve their sentence and are set free only to

repeat the same offense again. This is simply because they have no control over themselves and the very fact that they have done a deed once starts a habit and they do it again more easily. From the legal standpoint there is no justice in sentencing them for this crime or misdemeanor because they are not responsible. In terms of the usual legal question, "Did he know the nature and quality of his act and that it was wrong?" one has to answer; in the higher grade cases they probably *know the nature and quality of the act,* but they do not realize that it is wrong. It is true that they will *say* that it is wrong if you ask them the question, because they have learned to say that. They have heard it said that it is wrong, but they do not have any firm conviction, any true realization of what it means to be wrong.

In view of all this the question arises, how should such cases be treated? The answer is given briefly and nevertheless is remarkably accurate and significant. *They must be treated as children.* Whatever their age or experience in the world they are mentally children and when treated as such the best results are obtained. The writer has dealt with many a man and woman of perfectly normal appearance who maintained a reserve and dignity that was baffling until he approached them and talked with them as though they were children. Upon such treatment they immediately yielded and became talkative and natural, revealing their true mental state. When the question is answered from the social standpoint it means, of course, that these people must be cared for as children. This means, in the great majority of cases, segregation or colonization. In a certain percentage of the cases where the home environment is good and relatives of intelligence can exercise an oversight over them, and their temperament is favorable, they may be allowed to live in their community, doing such work as their mentality will warrant, and will lead harmless and happy lives.

It is rather a common notion that the feeble-minded are especially inclined to crime. In other words that they are naturally bad, vicious, wicked. This, however, is a mistake. As stated above, they are children and they are as innocent as children. It is true that they are easily made into criminals and when misunderstood and consequently mistreated, they are often driven to react and react in a criminal way. Not being able to take care of themselves or earn a living, they as a rule must either steal or become paupers. Not able to understand the ideas or ideals of normal associates, they are uncomfortable in their presence and seek the association of those more nearly of their own level, often defective or degenerate adults. The result is that they easily fall into the same degenerate mode of life. But if they are recognized as defectives early in life and are cared for and trained and kept away from evil influences, they practically always become docile, tractable, happy, harmless people.

It is the psychopathic cases of syphilitic origin above referred to that make the persistent delinquents of seemingly vicious tendencies.

The solution of this problem of mental defectiveness would seem to comprise therefore the following points:

1. Because the condition is so largely hereditary, feeble-minded persons should never be allowed to marry and every precaution should be taken to prevent them from becoming parents. If this could be done, their numbers would be greatly reduced in a few generations. They could not be eliminated, as formerly supposed, since their heredity follows the Mendelian Law, which means that there will, for a long time to come, be feeble-minded persons born of parents who are apparently normal, but who, because there is defect in their families, may nevertheless transmit defectiveness.

2. Those who are born must be early recognized and their status known, and they must then be trained in accordance with their mentality. It is practically impossible to give them any of the ordinary school education. Some of the best of them may learn to read and write and occasionally they become somewhat proficient in these branches. As a rule, however, the time spent upon such subjects is wasted. They are highly trainable in industrial pursuits, such as do not require a high intelligence, and when thus trained they can work patiently and faithfully, and under supervision can often earn enough to pay for their support. Therefore physical and industrial training is indicated for them. Industrial training includes being taught the most elementary activities, such as personal cleanliness and hygiene, house work, farm work, and simple occupations. In cities there are many things in shops and factories that they can do if they are trained to do them beforehand. They cannot go into a factory, as a normal young man or woman does, and in a few hours or days learn to do the job that the overseer has for them. Under such conditions the overseer becomes disgusted with them long before they have learned, and they are discharged.

3. Those who show tendencies that lead them into anti-social conduct such as sexual excesses, or who have no relatives or friends that are capable of controlling them, must be segregated in institutions or colonies.

As to training, the special schools or the institutions are at present the only agencies that can carry on the work understandingly. Therefore our program should be to train them industrially as fully as possible and then to try them at work on probation, under careful supervision and oversight both when at work and out of hours. Whenever they show tendencies that cannot be thus controlled, they must be sent back to the institution to work there the rest of their lives.

The following case histories will help the reader to understand the moron:

N. D., high grade moron, insane type, born, 1873, admitted 1891, discharged 1897. Upon leaving the training school he joined the navy, three years, received honorable discharge. Did manual work in Newark. Couple years later disappeared and for eight years no word

of him received. Then letter received from Insane Hospital in California permitting his dismissal after two years a patient there. Upon his return to Newark he told of first six years away filled with many wanderings and different jobs. In Newark father and brother secured a job for him—manual labor for street railroad at $12 a week. Made much trouble; went with girls of bad character. Fanciful ideas weaved about truths told as facts. Boarded and roomed near brother's home. Father and brother tried to keep in touch with his companions and recreation. After three years they succeeded in placing him in hospital at Morris Plains. After a few months he ran away but was returned. After year and a half ran away again. Belongings sent to father contained horrible letters from girls.

B. D., high grade moron, born 1900, admitted 1914, dismissed 1915. For a while lived with aunt in Hamilton, Ohio, worked in basket factory. He and mother went to Florida where he worked on farm for his mother. Cannot do very hard work, as not very strong. Worked at cement job, but too hard. Then worked in glass factory, melting down eye cups ($8 a week). "Work too hard," left there and grandmother got work for him as general helper in kitchen at boarding house ($2 a week and board). Could not keep him there as he was not a good worker and drank. Grandmother often had to help him, paying his board when he was out of a job. Finally implicated in chicken robberies, arrested and sent to the Rahway Reformatory.

X. D., high grade moron, born 1887, admitted 1896, dismissed 1903. Big, fine-looking fellow. Went on visit to aunt in Atlantic City; wanted to stay and try position that was offered. Worked at several different places, first with uncle at carpentry ($1 a day). Then for a cousin who was a plumber. Then "drummed around" from one place to another. On police force at Atlantic City the last three years; on police force during the summer, and in winter worked at plumbing. "Pays his board, is honest and liked generally." Now in the army.

D. E., low grade moron, born 1880, admitted 1898, dismissed 1899. For ten years lived at home and worked out at manual labor, such as digging, hauling, etc. Mother collected pay and provided clothes and spending money. Last eight years, since mother's death, works for woman who understands his mental condition; cares for horses and does hauling. Receives the equivalent of about $12 a week. Employer buys clothes and furnishes board and lodging (room in barn). Great weakness love of drink; not able to stand much. When he has money men easily persuade him into saloon. Resents any advance from sisters and brothers.

H. T., high grade moron, born 1878, admitted 1888, dismissed 1892. Ran away from training school; walked to home in Newark. Begged so hard to remain home was allowed to do so. Has been a great care and made life miserable for all; was morally a menace to younger children. Mother prepared to turn him out if he did not improve. This had its effect. He reformed somewhat. Earned $15 and $18

a week in shoe factory. Began to run with girls. At twenty-one married a girl and brought her home. Parents refused to keep him. Lived in rooms in wife's mother's home; no management; lived like pigs. Wife dressed extravagantly; picture of wife looked like actress. First child died as result of venereal disease; second child now fourteen in eighth grade. Moved to new home; took man lodger; much drinking; improper relations between lodger and wife. H. and wife quarreled; wife went home; H. drank heavily; lost his job; sent to prison; gotten out by aunt; leads most wretched life. Wife works in basement store; keeps daughter in school; has nothing to do with husband.

CHAPTER XXX.

MARITIME QUARANTINE.

By LELAND E. COFER, M.D.

Historical.—Quarantine (Lat. "quadraginta," Fr. quarante"—forty) has for centuries past been one of the numerous ways in which the public as well as the individual has manifested the natural instinct for self-preservation. Whether the individual or the public are familiar with the "quarantinable diseases," the result is the same when cases of smallpox, cholera, plague or yellow fever appear in their midst—they cry out, "Take it away," "quarantine it." In this manner has history been repeating itself since biblical times. In the book of Leviticus directions are given for the segregation, sometimes for stated periods, of lepers and in fact all persons suffering from skin diseases. There are other references in the Bible to precautionary measures ordered by the priests to prevent the spread of disease.

Maritime quarantine originated much later in connection with the Levantine trade, and its early history was associated with that of shipping in the Mediterranean, especially with that of Venice and Marseilles. It is recorded that the pest at Constantinople, A.D. 534, was carried by ships and that this invasion of disease became later the foundation of the quarantine establishments on the Mediterranean coast.

The Venetians were the first to make provisions for maritime sanitation. As far back as the year 1000 there were overseers of the public health. These officers were authorized to spend public money for the purpose of isolating infected ships, goods and persons on one of the islands of the lagoons surrounding the city of Venice. A medical man was stationed with the sick, and as a result of this arrangement the first thoroughly constituted maritime quarantine station of which there is historical record was established in 1403 on the island of Santa Maria of Nazareth at Venice. History tells us that the average maritime quarantine station of the sixteenth century consisted of an anchorage for vessels and barracks for suspects and convalescents and a place where "purification" could be applied.

It will be interesting in this connection to relate what happened to a Catalan ship that arrived at Palermo from Barcelona on the way to Naples, which shows at least that the quarantine officers of the sixteenth century were thorough in their methods. The vessel carried 97 persons, 18 of them passengers. Three seamen and two passengers had died of a disease suspected of being plague. The deaths occurred while the vessel was taking on cargo in the harbor where she lay at

anchor. The cargo consisted of barrels of salted fish, cases of sugar (destined for Palermo and already unloaded and in the warehouse), salted cheese and general merchandise. The master of the vessel was first requested to give an enormous bond as security that he would not leave the harbor until given pratique, and to make his leaving still more difficult the rudder was removed from the ship and a watch was set. All persons except the sick and sufficient seamen to guard the ship were sent ashore, where all garments were taken from them and they themselves exposed to the fumes of boiling pitch and afterward washed with vinegar. Some of their clothing was burned and some was washed, aired and perfumed for fifty days. The sick were removed to the hospital and the cargo was treated as follows: The barrels of salted fish were washed outside, first with sea water and then with vinegar. The cases of sugar and salted cheese had their coverings removed and burned and the commodities, without further treatment, were delivered to the owners. Merchandise was aired and perfumed for fifty days and the cloth fabrics unrolled and hung from the rigging of the ship for fifty days. The sails and cordage of the ship were taken down, submerged in the sea for a week and then hung from the masts, yards and booms in the air, sun and dew by day and night as long as the ship remained in quarantine. The ship was then fumigated by boiling pitch in caldrons between decks. It is needless to say that the treatment of vessels infected with plague is not so complicated today.

Organized quarantine in the United States was begun after the passage in 1893 of the act (approved February 15, 1893) entitled: "An act granting additional quarantine powers and imposing additional duties upon the Marine Hospital Service." Prior to 1893 the various State governments, and later the county and municipal governments, as the case might be, conducted their own quarantine affairs as police functions. In those days one port would offer special quarantine advantages in the line of competition for trade or retaliate against a specific port with severe quarantine requirements. If space permitted much could be written along these lines, some of which would be amusing, showing the disadvantages of these varied systems of operating quarantine in this country. However the passage of the above-mentioned act of February 15, 1893, showed that the people, through Congress, had decided that the system was faulty, a danger to the public health and a burden upon commerce.

TYPES OF VESSELS MET WITH IN MARITIME QUARANTINE PRACTICE.

The most important general classification of ocean carriers from a practical quarantine standpoint is that of modern vessels as opposed to those of the old type. The modern steam vessel is almost without exception large, with a general arrangement tending to the wide and distinct separation, by bulkheads and decks, of the three classes of passengers

on the one hand and the different departments of the ship's personnel on the other. Such vessels have high superstructures amidships, in which the first cabin passengers always and the second cabin passengers frequently live in a world apart from everyone else on board. The steerage passengers are usually quartered around the main freight hatches forward and aft below the spar deck and the seamen, firemen and messmen are on the same deck but in separate compartments amidships. The old type steam vessel, although carrying out our traditional ideas of what is nautical, is seldom large and is devoid of arrangement tending to a wide and distinct separation of classes and departments. The decks sweep gracefully fore and aft and the superstructure frequently affords direct communication with any or all parts of the ship. The quarters on such vessels are constructed with reference to the conservation of freight space, and the separation of classes on board is, from a quarantine standpoint, purely imaginary.

Ocean carriers are classified for quarantine purposes as follows:

1. Modern steam vessels.
2. Old type steam iron vessels.
3. Navy vessels and military transports.
4. Steel sailing vessels and tramp steamers.
5. Wooden vessels.

Modern Steam Vessels.—The modern large steam vessels are rapidly replacing those of the old type on the transoceanic routes, and they are undoubtedly far safer, from a sanitary standpoint, than the old type of vessels. The large steamers are so expensive to maintain that their runs are quicker and their time in port much shortened, all of which has a bearing on the chances of their becoming infected with the intermediate hosts of certain of the quarantinable diseases. These vessels are equipped with all the modern appliances for ventilating and for the automatic flushing of latrines. Below the water line the hull is divided into compartments by water-tight bulkheads, which probably limit the migration of vermin. Even the loftiness of the hull affords some protection against the ingress of vermin.

Old Type Steam Iron Vessels.—The old type steam iron vessels present rather the reverse of the conditions enumerated above, and for this reason are classified separately in determining their probable status from a quarantine standpoint.

Naval Vessels and Military Transports.—Naval vessels and military transports, while they do at times become infected with and are therefore capable of carrying quarantinable diseases, are comparatively safe for the reason that commercialism enters nowhere into their conduct and every officer on board is officially and invariably the guardian of their sanitary integrity.

Steel Sailing Vessels and Tramp Steamers.—Steel sailing vessels and tramp steamers usually make long voyages, visit many countries, have the carrying of freight as their sole aim and, in short, present the greatest hazard to the quarantine officer of any of the varieties of ocean carrier.

Wooden Vessels.—Wooden vessels are placed in a class to themselves, simply because once infected they present, on account of their construction, a great many obstacles to proper disinfection. All signs point to the complete substitution of steamers for sailing vessels, which fact has an important bearing upon the practice of quarantine, for the reason that quarantine work in steamers presents far greater difficulties than in sailing vessels, steamers being more easily and more often infected than sailing vessels.

THE QUARANTINABLE DISEASES.

The diseases usually quarantined against in maritime quarantine practice are cholera, plague, typhus fever, yellow fever and leprosy. It is always good practice for the quarantine officer to notify the local health body of the presence of any and all communicable diseases arriving on vessels.

The Inspection of Vessels.—The inspection of vessels is the most important part of quarantine practice. Successful maritime quarantine depends almost entirely upon its proper performance. In other words the inspection of a vessel holds the same relation to quarantine practice that the process of making a diagnosis does to medical practice.

An inspection of a vessel includes the consideration of the sanitary history of all ports visited by said vessel, the present health status or quarantine credit of these ports, the inspection of all persons on board and the collateral evidence bearing upon the sanitary status of the vessel.

The quarantine officer must be posted concerning the sanitary history and the present sanitary status of all the principal ports of the world, and should consider the bearing which the general sanitary history of a port may have upon the recent real or alleged health status thereof.

The recent sanitary status of a port is learned through the United States Public Health Bulletin, through the Consular and other bills of health carried by the vessel, and from special information received either by wire or by letter from medical officers of the Public Health Service, or from Consular officers stationed at the ports previously visited by the vessel.

The inspection of a vessel consists in the examination of all persons on board, and when necessary of the living compartments and holds.

The first step in the inspection is an examination of all the sick persons on board. After visiting the sick, the bodies of any persons who have died at sea are viewed, and a necropsy performed if necessary. Suitable bacteriological examinations are made in all suspected cases of either plague or cholera.

Next in order comes the general muster. The method and extent of examination of passengers and personnel of the vessel varies with the disease or diseases existing at the vessel's port of departure or

ports of call. In the case of vessels from plague infected ports, a glandular examination of steerage and crew may be necessary.

Even with a cursory inspection of a person standing in line, the boarding officer may detect any condition denoting illness not warranting the person's appearance at muster. This is mentioned because more than once men have been compelled to get out of bed and stand in line for the quarantine inspection. By a quick inspection such symptoms of leprosy as the claw-hand, drum-stick-fingers, elongated or nodular ear lobes and frontal or cutaneous thickening may be seen. Cutaneous eruptions of any description naturally suggest a further examination with a view of fixing or eliminating a diagnosis of variola. Unusual or marked cases of "sea-sickness" from cholera-infected ports naturally demand further investigation. Cases of pneumonia, either acute or convalescent, from plague-infected ports are examined especially for the presence of the plague bacillus.

The formal inspection of the vessel having been completed the boarding officer collects the collateral evidence as to the ship's sanitary status. The collateral evidence includes the general condition of the hull and the living quarters, the character and condition of the sanitary arrangements, and the condition of the decks and holds as to general cleanliness. It also includes the possible finding of dead rats during the voyage.

The source of water and vegetable supply and the kind of cargo carried are also considered in the light of collateral evidence.

The Diagnosis or Judgment of the Vessel.—The last step, the judgment of a vessel's health status, is arrived at by weighing the findings of the inspection, that is, the conditions which were apparent at the time of inspection against the possibilities of concealed infection or latent infection.

Either concealed or latent infection or even both of these conditions may apply to a ship itself or to the personnel. Concealed infection is usually concomitant with dishonest or ignorant masters or captains or with wily passengers and crew. Latent infection is a condition dependent upon the character of a vessel, her conduct while in an infected port, and upon the character of the quarantinable disease present in such ports.

When a captain of a vessel compels men sick with a quarantinable disease to stand in line to pass inspection, or makes a false certificate regarding the finding of dead rats on board during the voyage, he may be said to be concealing infection. On the other hand when a passenger or member of the crew has had a very mild, modified, or attenuated attack of a quarantinable disease which has escaped all notice, the disease on the ship may be said to be latent.

The determination of concealed or latent infection on vessels cannot be learned from books; it must be acquired or absorbed by long-continued experience and observation.

Concealed or latent infection is the cause of most of the failures in maritime quarantine work, therefore it frequently happens that a

boarding officer is forced in the interest of public safety to impose the burden of proof as to the absence of latent or concealed infection upon the vessel.

The facts which may be gathered by the ordinary inspection of a vessel comprise the information obtainable from the bills of health and the ship's papers, and the sanitary facts gathered by the boarding officer.

The apparent presence or absence of quarantinable disease is the most that can be determined by an examination of the vessel and its personnel. Instances are rife where careful and conscientious boarding officers have failed to detect cases of quarantinable disease in passengers who by means of careful planning were able to evade inspection.

The boarding officer must render his decision as to the vessel's status immediately after inspection, and the inspection must afford protection to the community and yet act as a sieve, not as a dam to commerce.

If the quarantine officer only had the facts above enumerated to consider, an opinion would always be prompt and probably exact, but the hazard of latent or concealed infection to which a large steamer, en route perhaps ten days from an infected port is liable, renders a decision possible only after consideration of the following conditions:

1. The probable sanitary history of the voyage.
2. The likelihood of latent infection.
3. The possibility of concealed infection.
4. The kind of cargo carried.

The probable sanitary history of the voyage involves the hazard of way port traffic; for example, if one hundred passengers of unknown origin board a vessel in Genoa and land two days later in Naples, their presence on board may or may not have altered the sanitary status of the vessel, but the number, origin and destination of the passengers together with the known sanitary conditions of the ports involved would raise a question in the boarding officer's mind upon the arrival of the vessel in the home port.

Latent plague infection, the likelihood of which must be reckoned with, could be caused by an infected rat being introduced into the vessel with the freight, or by the embarkation of a passenger suffering from ambulant plague. The passenger himself might recover from the illness without attracting attention and yet leave infection to spread later on.

The Kind of Cargo Carried.—A cargo is dangerous according to its general character. Coal, oil, ore, nitrates and the like are safe cargoes, while flour, cereals, grain and foodstuff are apt to harbor vermin and are therefore open to question. General merchandise is dangerous, but principally because the spaces which usually intervene between the parcels may harbor vermin.

A vessel may be found a safe risk in every other respect save in the cargo. A decision pending upon the status of the cargo is a difficult one to make, as on the one hand the public health may suffer and on

the other hand the vessel may be put to needless expense if quarantine treatment is not necessary. After all, the boarding officer must judge cargo by the possibility of its affording a habitat for the intermediate hosts of quarantinable diseases.

In short, the judgment of a vessel's status can only be obtained by a process of deduction, and the most successful boarding officer is the one who forms the largest number of correct deductions.

THE SEGREGATION OF PASSENGERS AND CREW.

In maritime quarantine practice suspected or infected vessels, together with all persons and effects on board are subjected to what is known as quarantine treatment. Under quarantine treatment, disinfection as a function and process is properly placed, and will be described elsewhere.

All persons suffering from quarantinable diseases are first removed from the vessel and placed in the contagious disease hospitals, the quarters just vacated by them being immediately subjected to fumigation by sulphur or hydrocyanic acid gas.

Next comes the removal if need be of first class, second class and steerage passengers in regular order.

After all persons have been removed from the vessel, the latter is subjected to a process of disinfection.

The treatment of persons from infected vessels varies with the kind, class, and number of the passengers, with the arrangement of the living quarters of the vessel, the type of vessel, the condition at the home port or port of arrival, and with the disease involved. Different classes of passengers may or may not have their effects disinfected according to circumstances.

DISINFECTION IN MARITIME QUARANTINE PRACTICE.

The treatment of baggage and personal effects.—Baggage and personal effects are disinfected by means of steam in steam chambers with or without formaldehyde.

The disinfection of fabrics, clothing and bedding in quarantine practice is usually accomplished by the use of either steam or formaldehyde in the usual double jacketed chamber with jetting steam or steam under pressure with formaldehyde gas alone or in combination with dry heat; also with a combination of these methods with or without a vacuum. The chamber is built with an inner and an outer shell. The steam jacket when heated prevents the condensation of steam in the disinfecting chamber by heating the latter before the steam is turned on. This prevents the wetting of the clothes and other articles to be disinfected. In using the chamber with steam, either with or without pressure, the steam is kept continually coursing through

the jacket. The chambers should be loaded with care, the clothes should be hung up in the disinfecting cars and under no circumstances stuffed in. Clothes are usually loosely arranged in wire baskets or gunny sacks, which are then neatly arranged in the disinfecting car. The baskets or gunny sacks are numbered with metal checks with duplicates, the latter to be held by the owner of the baggage during the process of disinfection.

The treatment of the vessel.—The disinfection of a vessel requires on the part of the disinfector some familiarity with the general arrangement of the interior of vessels and a certain amount of ingenuity. A vessel is seldom so badly infected as to require disinfection throughout. The hazard of an infected vessel varies according to the nature of the disease with which it is actually or presumably infected. Therefore, it is very frequently difficult to decide just what part of a vessel and just what personal effects should be disinfected. There is no reason why the staterooms of the first cabin passengers should be disinfected because there is a case of smallpox in the steerage or in the quarters of the crew. Likewise, there is no reason to disinfect the holds of a vessel and break the cargo in bulk because of a case of smallpox, cholera or typhus fever found in the cabin or steerage. Therefore, an infected vessel requires definite and especial quarantine treatment according to the nature of the disease with which it is infected. For example, in vessels infected or suspected of infection with cholera, especial attention must be paid to the drinking water on board, and the vegetables and fruit as well. In the case of plague, the destruction of rats and other vermin is of first importance. For yellow fever, measures must be taken against the presence of mosquitoes, (Aedes Calopus) and for smallpox and the eruptive fevers, the usual disinfection of living apartments, clothing, bedding and the personal effects of those exposed to infection is required.

After the quarantine officer has made a thorough inspection of the vessel he can determine the exact extent to which he will carry the process of disinfection. Such rooms as the carpenter shop, chain lockers, rope and sail lockers, lamp lockers, paint rooms, chart rooms, pilot house, engine and boiler rooms, machine shops, shaft alley and turtlebacks are usually not infected and therefore require no disinfection. It may be necessary, however, to fumigate these places for the destruction of rats and mosquitoes. The dining-rooms, social halls and smoking rooms usually contain a great deal of metal and gilt decorations, which are ruined by sulphur; therefore, the metal and gilt work in such compartments, when fumigation is required, should be protected by a coating of vaseline.

The agents principally used in the disinfection of a vessel are sulphur dioxide, hydrocyanic acid gas, formaldehyde gas and bichloride of mercury.

Sulphur Dioxide.—This is the most efficient of all of the disinfectants so far as the holds of a vessel or compartments are concerned. It is

equally destructive to animal and vegetable life, and it is therefore invaluable in quarantine practice in destroying contagion that is transmitted through the agency of mosquitoes, flies, bedbugs, rats and mice. Its action requires the presence of moisture in some form. The gas diffuses slowly and has very little penetrating power, therefore the use of sulphur gas should be limited to the disinfection of surfaces, it being unsuitable for the disinfection of bedding, mattresses and fabrics. It does not kill spores, and therefore is inapplicable to disease caused by spore-forming organisms. It should be borne in mind that sulphur gas bleaches all fabrics colored with vegetable dyes, and has a disintegrating action upon cotton and jute fabrics, such as sugar and fertilizer bags. In computing the amount of sulphur required for the disinfection of holds and compartments of vessels, the following rules should be remembered. One pound of sulphur burned in a space containing 1000 cubic feet will produce 1 per cent. of the gas. Five pounds of sulphur burned in a space containing 1000 cubic feet will produce 5 per cent. of the gas. This latter volume strength of gas is sufficient to kill all non-sporebearing organisms after sixteen hours' exposure. With 2 pounds of sulphur for every 1000 cubic feet, two hours' exposure is sufficient to kill mosquitoes and vermin. In disinfecting with sulphur all spaces must be rendered air-tight.

Hydrocyanic Acid Gas.—This gas is produced for ship fumigation by acting upon sodium cyanide with a mixture of sulphuric acid and water. For each 1000 cubic feet of space $3\frac{3}{4}$ ounces of sodium cyanide, $5\frac{6}{10}$ ounces of sulphuric acid and $7\frac{5}{10}$ ounces of water are used. For large spaces such as holds, barrels are used as generators; for small spaces such as storerooms, forecastles, cabins, etc., buckets are used. One hour is the time officially allowed for reaction, diffusion and penetration of the gas, after which the space is opened as widely as possible and ventilation encouraged. In fair weather and with a good wind and other favorable conditions, the clearing out is accomplished within a half hour; under cloudy and unfavorable conditions, not for an indeterminate number of hours. This gas is fatal to all kinds of animal life, is quick in action and is admirable as a time saver in ridding ships of rats and vermin, but it is extremely dangerous to human life and should only be used by responsible and careful persons. At the port of New York considerable fumigation has been effected by vaporizing liquid hydrocyanic acid.

Formaldehyde Gas.—In quarantine practice this gas is most conveniently and efficiently used by means of the autoclave. By the use of the autoclave, the gas is produced from a solution under pressure and not only is the gas evolved in a short time, but good penetration and diffusion are obtained. The solution used consists of formalin 40 per cent., with 20 per cent. of calcium chloride, or some other neutral salt such as common table salt. Ten ounces of the solution should be used for each 1000 cubic feet of space to be disinfected. The exposure period for holds or compartments is from five to twelve hours. Fabrics

hung up loosely in a compartment may be disinfected by an exposure of twelve hours. Formaldehyde gas is being used less and less in quarantine practice.

Bichloride of Mercury.—This agent should be kept on hand at Quarantine Stations in a tank with a capacity of at least 2000 gallons. The strength should be 1 to 1000. This solution is used in the form of a spray as a surface disinfectant.

The foregoing is barely an outline of maritime quarantine practice, which is changing as to conditions constantly and which must vary with and according to a large number of influences.

CHAPTER XXXI.

VITAL STATISTICS.

By WILLIAM H. GUILFOY, M.D.,

AND

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Statistics may be defined as the science of dealing with large numbers and presenting them in such a manner that the mind can easily grasp their meaning. Webster defines statistics thus: "Classified facts representing the conditions of people in a state, especially those facts that can be stated in numbers, or in tabulation or classified arrangement." Bowley defines statistics as "the science of the measurement of a social organism regarded as a whole, in all its manifestations." Statistics includes counting, segregating, tabulating and analyzing collected data; making estimates, *e. g.*, of populations, of crops, of mine outputs, etc., and lastly presenting these results in a readily understandable manner. King gives the following definition of statistics: "The science of statistics is the method of judging collected, natural or social phenomena, and the results obtained by the analysis of an enumeration or collection of estimates."

Vital statistics is that branch of the science that deals with the phenomena of the life of people, that is, births, marriages, illness and deaths, populations and the movement of populations, and may be defined as the bookkeeping of the health of a community or a nation. Newsholme has defined vital statistics as the science of numbers applied to the life-history of communities and nations; Wilbur calls it the Cinderella of modern public hygiene, sitting in the chimney corner sifting the ashes of dusty figures while the proud sisters, bacteriology and preventive medicine, go to the ball and talk about the wonderful things that they have done. It might also be defined as the numerical registration and tabulation of population, marriages, births, diseases and deaths, coupled with analyses of the resulting numerical phenomena with the end in view of "searchlighting" the path of sanitary progress.

Purpose of Vital Statistics.—Statistics, in general, are used as a guide to appropriate action in the efficient conduct of a business or of a government. Vital statistics are used as a guide to appropriate action in the maintenance and improvement of public health. Without vital statistics, a health officer would be unable to compare the health conditions in a community under his supervision with those previously existing or with similar conditions in other communities.

He would be unable to determine whether his efforts toward the reduction of illness and death were meeting with success. He would be unable to determine whether or not the public moneys entrusted to his care were being judiciously and wisely expended. He would be unable to present concrete evidence of the health needs of a community in support of a budget he may be submitting to an appropriating body. In making a plea for funds for health purposes, it is absolutely essential that one be able to present irrefutable evidence of the needs of the health work for which the funds are requested. Vital statistics, "the chart and compass of the sanitarian" alone can supply such evidence. A health officer, if he is to discharge efficiently the duties of his position, must have knowledge of the presence and location of preventable diseases in his community: (1) In order to check the spread of disease; (2) for epidemiological study; and (3) to determine and develop general policies for the reduction of the incidence and mortality of these diseases. He must have knowledge of the incidence and mortality of all causes of death, if he is to inaugurate campaigns against them and to measure the success of the methods adopted. For such knowledge, he must have recourse to vital statistics. It is evident, therefore, that every health officer should have a thorough understanding of the fundamentals of vital statistics, and, it will be our endeavor in the following pages, to set forth in a simple and readily intelligible manner, those things which are of primary importance. We shall deal with the subject matter in the following order: Population, marriages, births, deaths, rates and illness. An appendix will be devoted to the more technical statistical methods in order that the ambitious health officer may obtain further knowledge that will enable him to compare, analyze and present his statistics in a correct and scientific manner. Not a few proverbs or trite sayings have been applied to statistics. Perhaps those, most often heard are the following: "Figures can be made to prove anything—figures won't lie." "Statistics are often cut on the bias." "Statisticians, consciously or unconsciously, twist figures to fit the case." Most of these proverbs, however, have been disparaging to statistics and they reflect the attitude of the public mind toward the trustworthiness of statistics. The untrustworthiness that is at times found in statistics is not inherent in statistics themselves, but is rather a reflection of the ignorance or wilful untruthfulness of the interpreter. Unfortunately, a casual reader is unable to determine the results presented, the degree of accuracy of the basic data or to judge the truthfulness and ability of the author. Then, again, the data and tabulations may be entirely trustworthy, but the analyzer may have wrongly interpreted their meaning. Still, again, in carrying forward a statistical investigation, one is apt to let one's prejudices or preconceived ideas on the subject under investigation, influence one's judgment in the interpretation of the data or in the analyses of the results. On the other hand statistics conscientiously prepared often batter down existing fallacies. We may, therefore, lay down the following rules:

(1) Basic data should be accurate. If there is a possibility of error that cannot be corrected, the author should call attention to this possibility of error, and state the source of his information, in order that the persons studying his statistics may not be mislead. If, in the course of statistical study, it becomes necessary to use the data that has been collected by someone other than the author, the source from which the author has secured the information, should be stated, first, as a matter of fairness, and second, in order that the persons interested in his study may be able to refer to the original source of information, and they themselves judge of its truthfulness. (2) All statistical problems must be studied by an unprejudiced mind and in a scientific and unbiased manner. (3) Comparisons based on statistics should have an elementary foundation in common and if modifying factors exist, same should be stated or what would be much better corrected mathematically. (4) Quantities dealt with must be numerous enough to warrant proper deductions to be drawn therefrom.

History of Vital Statistics.—The earliest record of an approach to the use of statistics of population is to be found among the Egyptians; in the Bible, II Book of Samuel, xxiv, 1-9, King David commands Joab to number Israel and Juda with resulting report of 800,000 Israelites and 500,000 Judeans, it having taken nine months and twenty days to finish the enumeration; the Greeks took many censuses, vital and material; the Romans at the time of the Empire took a census every five years for a period of three hundred and fifty years and kept records of births and deaths, but as far as we are able to judge did not put the material to the practical uses in which modern vital statistics are employed.

Censuses were not taken during the Middle Ages. John Graunt was the first statistician to publish a table of mortality based upon the death registers of London, which were begun in 1592 and continued with additional data to the same for many years.

Halley the famous astronomer was the first individual to prepare a life table based upon the tables of births and funerals in the city of Breslau and published in the year 1693.

Deparcieux, in 1746, published an essay on the "Probabilities of the Duration of Human Life," based upon tables of mortalities of French annuitants.

Dr. Price, in 1783, constructed a life table based on the population and deaths in Sweden and Finland, this being the first national life table published.

Milne constructed the so-called Carlisle Table based on the population and deaths in Carlisle during the nine years 1779 and 1787, the treatise being published in 1815.

Dr. William Farr, the father of modern vital statistics prepared and published three life tables: The first appeared in the Registrar-General's Fifth Annual Report (1843), and was based on the deaths in England and Wales in the year 1841; the second was published in the Registrar-General's Twelfth Annual Report (1853) and was

based on the deaths in England and Wales in the seven years, 1838–1844; the third was published as a separate volume in 1864 and was based on the mortality in England and Wales during the seventeen years, 1838–1854. The following quotation from Dr. Farr's is taken from the Fifth Annual Report mentioned above and the contemplation of the unparalleled sacrifice of human lives in the greatest war of all times is offered as an excuse for its insertion: "Since an English life table has now been framed from the necessary data, I venture to express a hope that the facts may be collected and abstracted, from which life tables for other nations may be constructed. A comparison of the duration of successive generations in England, France, Prussia, Austria, Russia, America and other States, would throw much light on the physical condition of the respective populations, and suggest to scientific and benevolent individuals in every country—and to the Governments—many ways of diminishing the sufferings and ameliorating the health and condition of the people; for the longer life of a nation denotes more than it does in the individual—a happier life—a life more exempt from sickness and infirmity—a life of greater energy and industry, of greater experience and wisdom. By these comparisons a noble national emulation might be excited; and vital nations would read of sickness diminished, deformity banished, life saved—of victories over death and the grave—with as much enthusiasm as of victories over each other's armies in the field; and the triumph of one would not be the humiliation of the other; for in this contention none could lose territory, or honor, or blood, but all would gain strength."

Life tables were published by the German Imperial Statistical office in 1910, by the Registrar General's office of England in 1907–1908 and in 1916 by the U. S. Census Office.

The most important books upon the subject in English are *Vital Statistics* by Wm. Farr, M.D., published in 1885 by the Sanitary Institute of Great Britain; *Vital Statistics* by Arthur Newsholme, M.D., published in 1899 (third edition) by Swan Sonnenschein & Co. Ltd., London, New York agents The Macmillan Co.; an excellent pamphlet on the subject written by Dr. John W. Trask, Assistant Surgeon-General, U. S. Public Health Service, has been issued as supplement No. 12 to the Public Health Reports and can be obtained for the asking from the U. S. Public Health Service, Washington, D. C.

Essential Requisites of Vital Statistics.—There are two essential requisites for the preparation of vital statistics, two pillars upon which rest the superstructure of the subject, (1) the population as ascertained by the census or enumeration officials and (2) the returns of births, marriages, sickness and deaths. The statistics of the population must be classified according to sex, age, civil condition, color or race, occupation; and the births, deaths, sickness and marriage certificates or returns must be arranged in tabulations showing similar items to those called for in the population schedules so that ratios or numerical relations between both may be established.

CENSUSES.

The first census of modern times was taken in 1751 in Sweden and Finland; in 1790 the United States of America took its first census and every ten years thereafter; the thirteenth was taken in 1910. The first census taken in England was in 1801 and repeated decennially; the twelfth was taken in 1911.

Some of the Continental countries take censuses every three, and others every five years.

The increase in the population between censuses is called the actual increment and reflects the addition to it from all sources; the natural increment is the excess of births over deaths.

Errors in the Census. — In taking a census a number of errors are apt to creep in. The most common one and that of greatest interest to health workers, is the error in the statement of the ages by the persons enumerated. There is a strong tendency in women to understate their ages and examination of the census returns shows concentration of the female population at the early twenties, most noticeable among single women. Among elderly persons there is a tendency to overstate their ages. Among the less educated, particularly, there is a tendency to state their ages as a multiple of ten, that is, if they are thirty-eight or thirty-nine or forty-one or forty-two to give their age as forty. There is a lesser tendency to state ages in years ending in five, as twenty-five, thirty-five and forty-five. To overcome these two errors, it is customary to divide the population into ten-year frequency groups, ending with the fifth years, rather than with the "0" years. By this method the population is more evenly distributed. The concentration of the population at the "0" year is clearly shown in the accompanying table which has been taken from Bailey's "Modern Social Conditions," and by him, taken from the report of the Federal Bureau of the Census:

NUMBERS OF PERSONS OF NEGRO DESCENT IN THE UNITED STATES IN 1900.

Age.	Males.	Females.
68 years	7,924	6,688
69 "	7,071	5,982
70 "	20,224	22,908
71 "	3,271	2,645
72 "	4,994	4,146

Another error that is encountered in the census is due to the tendency of parents to state the ages of children under one year of age, as one year old, thus unjustly increasing the group between the age of one and two and decreasing the group under one year of age. For this reason it is inaccurate to base infant mortality-rates upon the population under one year obtained at the census. This matter will be further discussed in the paragraphs devoted to infant mortality. Still another serious error is encountered in the statements of occupation: In order that the effect of employment upon health and life

may be studied it is necessary not only to state the occupation itself but also the nature of the industry and, if possible, the length of time engaged in such occupation; otherwise the error will be made of comparing sickness or mortality of persons engaged in one occupation with those engaged in another but with the same general designation, the hazard being entirely different in one occupation as compared with the other, as for instance, a laborer in a general merchandise store with a laborer in a lead factory. The duration of employment in present and previous occupations should be stated because individuals whose health has been undermined by means of employment in hazardous occupations obtain entrance into lighter and less hazardous callings.

As we have already pointed out in a previous chapter, and as is shown in the accompanying diagram, the mortality changes from year to year of life, and since the age distribution of no two communities is exactly alike, it is apparent that we must have accurate knowledge of the age distribution of a community before we can compare justly its mortality with the mortality of another community.

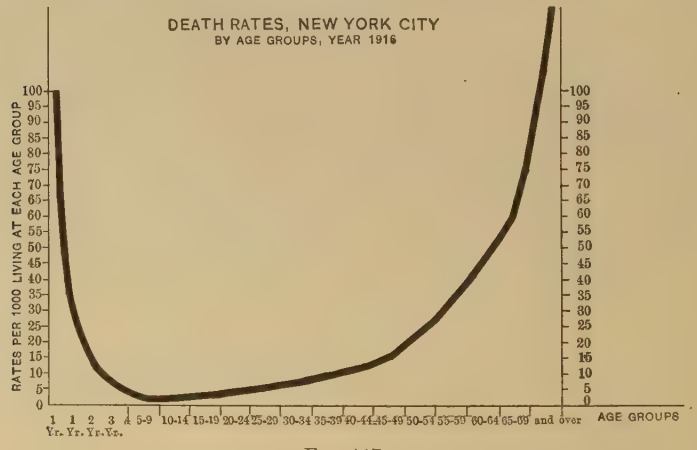

FIG. 117

It is common knowledge that populations of newly settled communities are apt to have an abnormally large percentage of young males, for the reason that unencumbered males are the first to emigrate and to risk the hardships of pioneer settlements. Communities that are slightly older, have an excess of both males and females between the ages of twenty and forty-five, because persons beyond forty-five years of age, are usually unwilling to risk the chances of unemployment and the discomforts and hardships encountered in newly settled communities. As communities grow older, children are born and the population is then composed of persons in middle life and children of early ages.

Since, as we have seen, sex, age, marital condition, etc., influence the the frequency of births, marriages and deaths, it is evident that we

must, in order to study these phenomena, know the total population in which they occur, and the number of persons in that population at each age, the number of each sex, the number of single, married and widowed persons, and the number of persons engaged in the various occupations, and this information can only be obtained by census. But since the censuses are taken at intervals of five or ten years, it becomes necessary to estimate the populations for intercensal years. There are two standard methods of estimating populations, to wit., arithmetical and geometrical. The arithmetical method simply consists in finding the annual increase in the population between two censuses, and its addition to or subtraction from the figures of the last census to determine the number of persons in the population during a intercensal or postcensal year, as shown in the following example:

Population by census of June 1, 1900, 200,520.
Population by census of June 1, 1910, 250,630.
Increase in population in ten years, 50,110.
Increase in population in one year, 5011.

If population of city in 1910 was 250,630, what will it be in 1911? Answer, 250,630 + 5011 = 255,641; in 1912 it will be 255,641 + 5011 = 260,652 and so on; if desired the population at any year between the census years may be ascertained in a similar manner. If the population in 1910 was 250,630, what was it in 1905? Answer, 250,630 − 25,055 (that is five times the annual increase) = 225,575.

As the estimates of the population by this method are based on the assumption that the amount of annual increase between census years will continue during the postcensal years and as it very seldom, if ever, does it become necessary on the receipt of the figures obtained at the next censal enumeration to recast or correct the estimates and to recalculate the rates for those years. The arithmetical method is the one in use by the Bureau of the Census at Washington, D. C., and as is evident by the preceding example is easy of application. The geometrical method is, however, more approximately correct in certain instances and as it requires a slightly higher grade of mathematics, it will be described in the appendix to this chapter.

Marriage Statistics.—Marriage statistics are of value from legal, social and a public health viewpoints. We will discuss the value of marriage records from the viewpoint of public health first.

The number of marriages in a community has a direct relation to the legitimate birth-rate, and since the population is depleted by deaths and replenished by births, the importance of marriage statistics is apparent. The data usually contained in marriage certificates or reports that are of interest to the health officer are age, color and the nationality of the persons married. From a social viewpoint, marriage statistics are of importance since they shed light upon the prosperity and morality of the community. From a legal viewpoint marriage statistics are of importance because of the many uses to which they are put, *e. g.*:

1. In proceedings for divorce or separation the marriage of the complainant to the defendant must be established.

2. A record of the second marriage before the dissolution of the first, is *prima facie* evidence upon which may be granted a decree of divorce of the parties contracting the first marriage.

3. As evidence of a previous marriage from which the defendant has not been released by divorce or death, in proceedings to annul a subsequent marriage.

4. As evidence of bigamy for the purpose of prosecution.

5. As evidence of marriage in order that a widow may obtain her lawful share of her husband's estate.

6. To prove legitimacy of heirs.

7. As evidence upon which to correct the civil condition of the deceased in a record of death.

8. As evidence of a widow's right to pension, under the Widows' and Orphans' Pension Act.

9. As evidence upon which a widow may obtain compensation for the death of her husband, as provided by the Workmen's Compensation Act.

10. As evidence of the right of the widow of a soldier, sailor, policeman, or fireman to receive a pension from the federal or local government.

11. As evidence upon which to change the record of birth of an illegitimate child. (It is customary in the Department of Health of the City of New York, when the parents of an illegitimate child subsequently marry, to permit them to file a certificate of birth of such a child, from which it shall appear that the child is legitimate—as it becomes after the marriage of its parents under the provision of the Domestic Relations Act.)

The average age at the time of first marriage has advanced during recent years, brought about by changing social and economic conditions, principally, the increased cost of living, the unwillingness of young people to assume the risks and obligations of married life without an assured income and the entrance of women into business and the professions. Nationality also exerts a very important influence upon the marriage-rate and the age at the time of marriage. It is true, in the City of New York at least, that foreigners marry earlier than natives; that foreign men marry to a greater extent than native men. The marriage-rate is probably higher in cities than in rural communities because young folks are attracted to the city by the more numerous opportunities of employment and the higher wages procurable. Financial conditions have an important bearing upon the marriage-rate. Indeed, the marriage-rate is a very dependable index of prosperity; during the years of plenty it increases; during the years of hardship it declines. It is an interesting phenomenon that the marriage-rate declines during the years in which the presidential elections are held.

The advance in the average age at the time of marriage, since it shortens the period of child-bearing, is responsible in a measure for

the decrease in the birth-rate which has occurred during late years in almost every civilized country in the world.

Marriage statistics are secured by compelling clergymen, civil officials and other persons permitted by law to perform marriage ceremonies, to file reports of the marriages at which they officiate with the registration office. Many of the States have within recent years enacted marriage license laws, which require that all persons before being married must secure a license from a designated official, usually the city or town clerk. This license must be presented by the couple to be married to the officiating clergyman or official, whose duty it is to fill out that portion of the license which constitutes the certificate or report of marriage, and return the said license and completed certificate to the city clerk. In some States, where a marriage license law has been enacted, no provision has been made for the ultimate filing of these records with the Department of Health, and since the law wisely did not repeal the original registration law, there is in certain cities a duplication of records, since the officiating clergyman or official is required to return the license to the city clerk and also to file a certificate of the marriage with the Department of Health.

Methods of Calculating the Marriage Rate.—Marriage-rates may be expressed as the proportion of marriages to the total population, usually the number of marriages per thousand of the population. (The number of marriages, of course, is one-half the number of persons married.) This is known as the crude marriage-rate, and, like all crude rates is of value only as indicating the frequency of marriage in the same community from year to year. In other words, it cannot justly be used to compare the frequency of marriage in one community with the frequency in another community, because in probably no two communities are the number of persons at the marriageable ages the same, and in many communities, especially those recently settled, there is a preponderance of males as compared with females.

The marriage-rate may be expressed as the number of marriages for each thousand of the population fifteen years and over. The most accurate method of stating the marriage-rate, however, is to state the rate in proportion to the number of unmarried, divorced and widowed persons of marriageable age, usually considered as over fifteen.

Birth Statistics.—Birth statistics are of value because of the information they furnish for public health, legal and social purposes. From the viewpoint of public health, the use of birth statistics may be divided into statistical and administrative. To the statistician, birth records are of interest because the population is replenished by births—the growth of population being due in measure to the excess of births over deaths; because of the effect of the birth-rate upon the age distribution of the population; because the birth records contain information of the nationality of the parents, and, when used in conjunction with mortality statistics, enable the statistician to compare the infant mortality of different races. The statistician is further interested in birth statistics, because the most accurate method of stating the infant mortality-rate, is, in proportion to the number of

children born, and it is evident that unless there is complete registration of births, this method is faulty.

The birth statistics furnish the sociologist with much interesting information; to particularize—the amount of illegitimacy, the fecundity of different races, the comparative fecundity of different classes, etc. From an administrative standpoint, the health officer is interested in birth records, because they are indispensable to infant welfare work, since they enable him to get in touch with the mothers within the first few weeks of their infants' lives, for the purpose of instructing and aiding them in the care of their offspring.

Among the legal uses of birth records, the following are some of the more important:

In Surrogates' Courts: 1. As proof of age and legitimacy of heirs. (This is probably one of the most important uses of birth records.)

In Criminal Courts: 2. To determine whether a minor defendant shall be tried in the Childrens' Court or in General Sessions.

3. As proof of age of the complainant in cases of rape.

4. As proof of birth in bastardy proceedings.

Birth records are also used for a number of purposes, as follows:

1. Admission into the public schools.

2. Obtainment of certificates of employment between fourteen and sixteen years of age.

3. Proof of age for exclusion from provisions of selective service in the army or navy.

4. Proof of dependency in claiming exemption from military service.

5. Obtainment of passports.

6. Obtainment of license to marry.

Registration of Births.—In order that the birth statistics be of value registration must be complete. In the registration of births, the United States has been particularly backward. Even today, in many cities of the Union, little or no attention is paid to the registration of births.

A short time ago the Federal Bureau of the Census established a registration area of births, to which were admitted all States in which registration reached 90 per cent. or over of all births occurring therein. In States that had not complete registration, cities with complete registration were admitted to the registration area. The usual procedure in the registration of births is as follows:

The attendant at birth—the physician or midwife—fills out a blank supplied by the Department of Health, and returns same to the local office. The local office either files the original and sends a copy to the central office, or files a copy and sends the original to the central office. In cities of the first class in New York State, original certificates of birth are filed at the local office and are not returned to the State Department. The Bureau of the Census, in consultation with the American Public Health Association, the American Bar Association, and other similar organizations, had provided a model registration law which it urged separate States of the Union to adopt, not only that the States might have satisfactory registration laws,

but that the latter might be uniform and the statistics prepared therefrom uniform and comparable. During the past several years, many of the States have adopted this law and the outlook for universal adoption throughout the Union is hopeful. The enactment, however, of a satisfactory registration law is but the first step in the collection of birth statistics. Completeness of birth statistics has suffered because of the little demand for official records of birth until recent years. With the development of practical uses of birth statistics, public interest in them was awakened. In the city of New York, the greatest impetus to complete registration of births was secured when the Board of Education found itself unable to house in the schools all the children who clamored for admission, and, in order to cut down the enrollment, necessitated that every child applying for admission present evidence that it was of school age. Since that time, other uses of statistics have still further increased interest in complete registration, and have aroused public opinion in support of the policy of strict enforcement of the registration law, with the punishment of offenders. Therefore, in order to secure complete registration of births in a community, the health officer should endeavor to awaken public interest in birth registration and arouse public opinion in support of his efforts to obtain complete registration, by finding practical uses for birth records. Having accomplished this much, he should lay down a policy of strict enforcement of the law and adhere to it without favoritism or prejudice.

Method of Originating Complaints.—Complaints against physicians or midwives for failure to report births should originate in the central office, or in the State Bureau of Vital Statistics, in order that all possibility of favoritism and prejudice may be removed. Upon the receipt, by the local officer, the certificate of birth should be immediately stamped with the date of receipt. Upon its arrival at the central office, comparison of the date of birth with the date of receipt, will determine whether or not there is reason for complaint. After the complaint has been made, the offending physician or midwife should be given an opportunity to offer such excuse as they may have for their negligence. It will probably be better in the administration of the Department of Health to have the State Registrar, on certain days each month, visit certain localities in the State. It obviates the necessity of physicians visiting the Capitol, where the central office is usually located, with consequent expense and loss of time. In the city of New York, the policy of the Department of Health is to excuse first offenders, provided the certificates have been sent in voluntarily. In all cases where the negligence is discovered through the efforts of the Department of Health, for a first offense, as well as subsequent, the offender is prosecuted. The law of the city of New York permits the Department to bring either civil or criminal action, or both, against an offender. The general procedure is to begin civil action, criminal action being reserved for the most chronic offenders. The corporation counsel of the city is authorized by statute to accept a fine where the defendant confesses judgment,

This procedure expedites matters and not only saves the Department the expense and trouble of taking all cases to court, but also saves the physician or midwife in a similar manner.

A complaint or delinquent file should be maintained in the central office and record of every complaint made should be placed in the file. In this way, when preparing a complaint, a record of the offender's previous history can be readily obtained and a statement incorporated in the complaint for the guidance of the prosecuting official; when the complaint has been terminated, either by prosecution and the imposition of a fine, or by the excuse of the offender the results should be entered upon the card for future reference. The following are some of the more useful methods of detecting violations of the birth registration law:

1. Compare the reports of deaths of infants under one year of age with the birth register.
2. Compare the enrollment of milk and infant welfare stations with the birth register.
3. Compare the reports of communicable diseases among the children under two years of age with the birth register.
4. Secure the coöperation of district nurses and medical inspectors in detecting and reporting unreported births discovered on their daily rounds.
5. Have the Health Department employes take censuses of children under one year of age in districts where the completeness of registration is questioned.
6. Compare birth notices in local press and news items referring to births with the birth register.
7. Carry on publicity campaigns for the purpose of acquainting residents of the State with the great legal importance of a birth record, and the hardships unnecessarily brought upon a child, by the physician, midwife or parents who neglect the important duty of recording a birth.
8. Upon the receipt of a birth certificate send the physician an acknowledgment and the parents a neatly lithographed certificate, showing that their child's birth had been properly recorded. (It soon becomes common knowledge that the Department sends such certificate and parents learn to look for it when a child is born, and if one is not received, will inquire of the Health Department the reason that they have not received one.)

Methods of Stating the Birth-rate.—There are several methods of stating the birth-rate:

1. The crude rate is the number of births in proportion to the total population, usually stated as so many births per 1000 of the population. The rate is calculated by multiplying the number of births by "1000" and dividing the product by the population. In a community having a population of 1,000,000, in which 30,000 births were reported during the year, the crude rate equals 30 per 1000:

$$\frac{30{,}000 \times 1{,}000}{1{,}000{,}000} = 30$$

2. The second method is to state the number of births in proportion to the number of women between the ages of fifteen and forty-five. This method is more accurate than the crude rate, but not as accurate as the third method, which is to state the number of legitimate births in proportion to the number of married females between the ages of fifteen and forty-five and the number of illegitimate births in proportion to the number of unmarried females between fifteen and forty-five years of age.

The crude rate is of value in comparing the birth-rate of the same community from year to year. It is of a doubtful value when comparing the birth-rate of different communities, for the very evident reason that the percentage of females especially of married females at the child-bearing ages in a community determines the birth-rate. The following are the factors which influence the crude birth-rate: The tendency throughout the civilized world to postpone the age of marriage, has been probably one of the most important factors in lowering the birth-rate.

It is evident that the retardation of marriage shortens the period of child-bearing and therefore decreases the number of pregnancies. The next most important factor in the reduction of the birth-rate has been the prevention of conception by artificial means, which is practised by many people, who, either desire to entirely avoid the responsibilities of parentage, or who wish to control the size of their family. It is a well-known fact that among the foreign-born who take up their residence in this country and marry the birth-rate is several times higher than among the first and second generations of the same stock born in this country.

The reduction of infant mortality has tended also to reduce the birth-rate, because, where infant mortality is high, children die within the early months of life, the mother ceases nursing and again becomes susceptible to impregnation; whereas, where the infant mortality is reduced and the child survives the period of lactation is prolonged and the chances of reimpregnation are lessened. A high birth-rate does not necessarily mean a prosperous or rapidly growing community. On the contrary, in all countries where the birth-rate is high, infant mortality is also high, so that a high birth-rate may indicate nothing more than a waste of life, needless suffering and expense for nursing and prenatal care.

The prevalence of venereal diseases, especially gonorrhea, is undoubtedly an important factor in reducing the birth-rate. A large percentage of the number of the cases of sterility, male and female, is due to gonorrhea.

The above factors influence the birth-rate no matter how calculated. The following factors affect the crude birth-rate: Financial conditions, as we have shown in a previous chapter on marriages, affects the marriage-rate and consequently, in turn, the birth-rate, as a high marriage-rate is usually succeeded by a high birth-rate and *vice versa,* during war the birth-rate declines because the men at

marriageable ages are on military duty; the termination of the war and the return of these men to the population are usually followed by an increase in the birth-rate; social position exerts an influence upon the birth-rate, through two factors which we have already mentioned, *i. e.*, the retardation of the age of marriage and birth control, and through the lowering of infant mortality, that is to say, that the persons in the higher social positions marry later. They are more apt to purposely regulate the size of their family. They are able, because of their better economic condition, to take better care of their children, and, hence, the mortality among their offspring is low, and in consequence, the birth-rate of people in the higher social spheres is lower. In other words, there is less waste of infant life. The birth-rate is usually higher in cities than in country places, for the reason that young people are attracted to the cities by better opportunities of employment, higher wages, variety of amusement and social life, consequently, there is a larger proportion of persons at the marriageable and child-bearing ages in the city than in the country. Religion exerts an influence upon the birth-rate only inasmuch as it prohibits the limitation of offspring. It is noticeable that throughout the entire civilized world there has been a gradual decrease in the birth-rate extending over a number of years. If, however, a curve is plotted for the number of infants who survive the first year of life, this curve will take either an absolutely horizontal or an upward trend, so that while there are fewer children born today, a greater number reach womanhood and manhood, and, if mortality is reduced, it is reasonable to assume that morbidity among children is also reduced; in consequence there are fewer persons in the population with physical impairments left by the diseases of childhood than in former years, and we may say that there has been a progressive improvement in the health of the multitude.

Professor Glover, in life tables which he recently prepared for the Bureau of the Census, conclusively showed that the natives of native parents, had a longer expectancy of life than did the foreign-born population in the United States, and this may well be attributed, in part at least, to the fact that the natives of native parents have avoided many of the diseases of childhood.

Stillbirths.—Stillbirth statistics are of interest from the viewpoint of public health as well as from legal and social viewpoints. From the viewpoint of public health stillbirths cause useless suffering and are indicative of injurious environment or the presence of disease.

From a social viewpoint, stillbirth statistics are of interest because of the waste of human life, because of expenditure of money for medical care and nursing of the mother and for the burial of the fetus. The causes of stillbirths are an index of the hazards of certain occupations of the mothers during pregnancy.

From a legal viewpoint, stillbirth statistics are of interest because demand is made for production of these records in various civil and criminal court actions.

In many communities, not until after the fetus has reached the period of viability, usually the seventh month, are physicians and midwives required to report stillbirths. It is evident that the stillbirth-rate in such communities is much lower than in communities where a stillbirth is defined "as the expulsion of the product of human conception at any time before full term."

If stillbirth statistics are worth collecting, then there should be uniformity of procedure, and it is our belief that all stillbirths should be reported. The following is a copy of the stillbirth certificate in use in the city of New York and devised by the authors. It is probably the most complete stillbirth certificate in use anywhere:

DEPARTMENT OF HEALTH OF THE CITY OF NEW YORK.

BUREAU OF RECORDS.

No fetus of any period of uterine gestation should be interred or disposed of in any other manner without a permit therefore having been obtained from the Department of Health, such permit to be granted upon the presentation of a proper return.

Persons who are unable or unwilling for any reason to bury a fetus should immediately notify the Department of Health, which Department will see that the fetus is properly and promptly bured in the City Cemetery.

CERTIFICATE OF A STILLBIRTH.

The death of an infant that has breathed must not be reported as a stillbirth; such cases must be reported by filing a certificate of birth and a certificate of death.

Borough of..... Registered No.....

No.....St. Character of premises, whether tenement, private, hotel, hospital or other place, etc.....

Sex.....Color or Race.....Date of Stillbirth.....191.. (Month) (Day)

	Father	Mother
Name		
Residence		
Birthplace		
Age	Color or Race	Color or Race
Occupation		

Period of Utero Gestation	Number of Previous Pregnancies	Number of Living Births

Margin reserved for binding
NO MUTILATED CERTIFICATE WILL BE RECEIVED
The particulars required on this Certificate must be written with black ink

I hereby certify that the foregoing particulars are correct as near as the same can be ascertained, and I further certify that I attended at this stillbirth; that the stillbirth occurred on the.....day of.....191..., that the actual cause of the death of this fetus was.....

.....and that said death of fetus occurred $\frac{\text{before}}{\text{during}}$ labor.

Predisposing cause.....

Witness my hand this.....day of.....191 Signature.....M.D.

Filed..... Address.....

Place of Burial		Date of Burial	
Undertaker		Address	

(Reverse)

STILLBIRTH PROCEDURE FOR MIDWIVES

Should the child not breathe after birth, the midwife must report the fact at once, by telephone or messenger, to the Department of Health, when an inspector will visit the case and countersign the stillbirth certificate which the midwife must leave at the home.

The fetus must not be removed from the premises until this certificate has been approved by the inspector from the Department of Health and a permit has been issued by the Bureau of Records.

The causes of stillbirth are many. Perhaps the most important is syphilis; other causes are too frequent pregnancy, previous miscarriages, overwork of the mother during pregnancy, general febrile illness, such as typhoid fever, pneumonia, etc. Labor is often induced prematurely to save the life of the mother, particularly when the mother is suffering from eclampsia, tuberculosis, heart disease, etc.

Methods of Computing Stillbirth-rates.—The stillbirth-rate, may, like the birth-rate, be stated: (1) As the number of stillbirths in proportion to the total population; (2) as the number of stillbirths in proportion to the number of women at the child-bearing ages; (3) as the number of legitimate stillbirths in proportion to the number of married women in the child-bearing ages and the number of illegitimate stillbirths in proportion to the number of unmarried women at the child-bearing ages. Again, stillbirths may be stated as a percentage of the living births, or of the total number of births living and dead.

In many communities it is the custom to include among stillbirths, the deaths of infants dying within the first few days of life. This custom is altogether blameworthy since it vitiates the statistics of stillbirth and infant mortality compiled in this manner. When the deaths of puerperal diseases are stated in proportion to the number of births reported, stillbirths should be included as well as living births.

Deaths.—Mortality statistics are perhaps the most important of all vital statistics, and next to population statistics were the first to be collected, tabulated and studied. Mortality statistics are of importance from the public health, life-insurance, legal and social viewpoints.

Since we shall devote most space to the discussion of the public health uses of mortality statistics, we shall clear the field by first stating the legal and social uses of such statistics. The following are some of the more common legal uses of mortality records.

In the Surrogates' Courts: As evidence of death in probating a will.

As evidence of death of a parent in applications for appointment of a guardian.

As evidence of death of an heir.

In Civil Courts: As evidence of death in accident cases of which they form the basis of action.

To explain the non-appearance of a witness whose testimony is required in any civil action.

In Criminal Courts: As evidence of death of a defendant in order to secure the discharge of the bondsman who has given bail for his appearance.

As evidence of death in order to have indictment against deceased dismissed.

Miscellaneous Uses: As evidence upon which to collect insurance upon the life of the deceased.

As evidence of the cause of death in order to collect accident insurance on the life of the deceased.

As evidence of death of a beneficiary of a life insurance policy.

As evidence upon which to collect bank deposits of deceased persons.

As evidence of death of a subject ordered to report for military duty by those foreign governments which compel all their male subjects to perform military duty.

As evidence of death in applications to the Police Department to remove a picture of a deceased person from the rogues' gallery.

As evidence of death to be submitted to a city or governmental department, which has been paying pension to the deceased.

As evidence of death to be submitted to the Workmen's Compensation Commission.

As evidence of death of civil or other pensioners, in order that their widow or other dependents may be granted one, in lieu of that paid to the deceased.

Evidence upon which to secure widows' and orphans' pensions.

As evidence of death of an illegitimate child, in order that the father may be released from further payments for its care.

Mortality Statistics.—From an actuarial standpoint, mortality statistics are of importance, because they are the very foundation upon which life insurance is built. Without mortality statistics scientific life insurance would be impossible.

Death statistics are of value from a social point of view, because of the information they give of the social life of the people.

From the viewpoint of public health, death statistics are of importance, because they form the most reliable index of the health of a community. They are also of interest because of the light they shed upon the importance of different diseases and because they serve as an index of the success that has attended human efforts to reduce illness and prolong life. From an administrative point of view, death statistics are of value in public health work, because the reporting of deaths enables the health officer to investigate the causes of death and to take such action as may be necessary to control the spread of communicable diseases.

Death-rates. — A death-rate is the ratio between the number of deaths and the number of persons in the population. It is generally expressed in terms of the number of deaths per 1000, 10,000, 100,000 or 1,000,000 of the population.

The term crude or general death-rate is applied to the ratio between the number of deaths annually per 1000 of the population and is obtained by dividing the number of deaths by the number of thousands in the population as, for instance, if there were 1200 deaths in the year 1917 in a city with a population of 100,000 the crude death-rate would be 12 per 1000, obtained by dividing the number of thousands in this instance 100, into the number of deaths. In the city of New York, in 1917, there were 78,575 deaths reported in an estimated population of 5,737,492, the manner of obtaining the rate being expressed thus: $78{,}575 \div 5{,}737{,}492 = 13.70$.

COMPARATIVE MORTALITY, FOREIGN CITIES AND CITY OF NEW YORK, YEAR 1917.

Cities.	Estimated population.	Total deaths.	Death-rate.	Total births.	Birth-rate.	Typhoid, rate per 100,000 pop.	Scarlet fever, rate per 100,000 pop.	Diphtheria and croup, rate per 100,000 pop.	Smallpox, rate per 100,000 pop.	Measles, rate per 100,000 pop.	Whooping cough, rate per 100,000 pop.	Epd. c. s. meningitis, rate per 100,000 pop.	Ant. poliomyelitis, rate per 100,000 pop.	Influenza, rate per 100,000 pop.	Pul. tuberculosis, rate per 100,000 pop.	Other forms of tuber., rate per 100,000 pop.	Cancer, rate per 100,000 pop.	Lobar pneumonia, rate per 100,000 pop.	Bronchopneumonia, rate per 100,000 pop.	Diarrhea under 5 yrs., rate per 100,000 pop.	Infant death-rate, per 100,000 pop.
Amsterdam	630,695	7,885	12.50	14,123	22.39	4.8	8.6	5.9	0.0	18.7	21.6	2.7	6.5	5.7	163.3	46.1	128.1	67.1	50.0	14.6	63
Barcelona	629,486	16,253	25.82	14,625	23.24	78.8	5.9	26.0	6.7	23.7	3.8	305.0	112.2	21.4	261.3	33.4	115.0	143.3	111.2	164.4	503
Birmingham	900,000	11,274	12.53	17,706	19.68	0.8	1.3	12.4	0.0	37.0	14.6	2.4	0.1	10.9	129.9	26.2	101.3	47.2	46.8	31.4	101
Bologna	201,940	3,375	16.71	2,664	13.09	12.4	3.4	5.9	0.5	8.4	5.4	5.4	0.0	10.4	155.0	57.4	114.4	18.0	6.2[1]	50.5	
Bradford	296,892	4,085	13.76	3,879	13.06	1.0	1.0	13.5	0.0	38.1	9.1	2.4	0.0	18.8	108.1	31.7	126.6	43.8	49.5	11.5	132
Edinburgh	333,043	4,924	14.79	4,913	14.75	0.6	5.4	19.8	0.0	62.5	57.6	2.4	0.0	7.8	117.4	55.2	125.8	11.0	3.5[1]	13.5	123
Florence	259,239	5,848	22.56	2,968	11.45	30.9	1.9	11.6	3.1	4.6	9.6	10.0	1.5	5.4	306.6	112.6	173.2	116.0	149.3	50.1	188
Genoa	341,104	5,636	16.52	4,840	14.19	14.7	11.7	17.3	0.9	3.8	5.9	2.1	0.0	3.5	224.8	40.7	98.5	19.0	4.6[1]	53.3	150
Glasgow	1,105,529	16,691	15 09	24,016	21.72	1.3	3.3	13.8	0.0	56.9	77.5	4.3	0.0	6.6	127.1	56.3	100.1	13.0	6.7[1]	38.3	129
Lyons	650.000	9,625	14.81	6,161	9.48	5.1	1.2	29.4	0.6	3.7	1.1	0.0	0.0	7.5	152.1	45.0	118.9	86.2	46.9		
Manchester	762,349	10,207	13.39	12,841	16.85	1.3	2.0	8.3	0.0	36.3	6.4	0.7	0.1	12.9	156.9	47.1	101.0	59.2	62.7	33.8	111
Marseilles	590,634	12,838	21.75	6,918	11.72	27.3	1.5	9.3	0.7	26.3	8.8	3.1	0.0	23.5	268.7	51.3	85.7	76.7	315.6	16.4	53
Milan	703,104	11,790	16.77	8,447	12.02	54.4	2.8	7.5	0.0	4.8	4.4	9.5	7.2	4.1	187.0	62.4	107.8	17.0	6.8[1]	60.7	138
Paris	2,847,229	44,200	15.52	32,830	11.53	5.7	2.7	6.6	0.0	20.9	4.1	3.4	0.0	4.3	295.8	54.7	119.2	48.5	174.1	..	96
Stockholm	410,800	4,883	11.88	6,801	16.55	0.5	21.7	11.7	0.5	8.0	4.4	2.0	0.2	3.4	194.2	37.7	119.5	76.7	...	15.3	74
Zurich	209,500	2,187	10.44	2,757	13.16	0.0	1.9	7.2	0.0	6.2	6.7	1.4	0.5	14.3	132.2	41.0	125.5	53.9	48.7	8.6	70
New York	5,737,492	78,575	13.70	141,564	24.67	4.0	2.0	20.0	0.0	10.0	8.0	3.0	9.0	11.0	154.0	23.0	85.0	127.0	66.0	59.0	89

[1] Combined rate lobar- and bronchopneumonia.

The crude rate of a city, State or country is used chiefly in comparisons with the crude rates of previous years and may be used in comparisons with rates of other cities, States or countries provided the sex and age constitution are approximately the same. If there be a decided difference in the sex and age grouping of localities or communities whose death-rates are to be compared, there should be allowance made for this dissimilarity by a standardization of the rates. This procedure is explained in the appendix to this chapter.

The table on page 822 gives in the third column the crude death-rates of certain foreign cities and the city of New York for the year 1917.

Crude Death-rates. — The extreme variation between the crude rates of the various cities is exemplified in the rate of 10.44 for the city of Zurich and 25.82 in the city of Barcelona. Of course it is understood that the crude death-rate of a city or country is not by any means an accurate yard stick to measure the comparative mortality among cities or countries, as the factors of sex and age distribution play a most important part in determining the crude death-rate of a community. Nevertheless, it is fair to assume that the age constitution of the cities mentioned in the table is not so widely variant as to explain the striking contrast between some of the rates. Another difficulty that presents itself is the inability to make allowances for the departure of the soldiers and sailors to the seat of war from many of the cities mentioned in the table and for the failure of the officials to divide the deaths into the two groups of civilians and returned soldiers. This latter factor might possibly be considered a negligible one as most of the deaths among the armed forces took place in battle or in hospitals situated at or near the front or at least outside of the area of the cities specified.

Weekly Death-rates.—A weekly death-rate expresses the number of persons who would die yearly provided the same number of persons died every week as died in the week under consideration. If 100 persons died in a city in the week of October 26, 1918, and the estimated mid-year population was 400,000 then the sum would be expressed as follows:

No. of deaths.		No. of weeks in a year.		No. of thousands in population.		No. dying of every 1000 of population.
100	×	52.17747	÷	400,000	=	13.04

Monthly Death-rates.—As the number of days in each month is not a constant factor it is necessary in order to obtain correct rates to make allowance for the number of days in each month in preparing monthly rates. In the month of September, 1918, in the city of New York there were 5013 deaths reported, the rate for the month being calculated as follows:

Estimated population.	No. of deaths.	No. of months in year.
5,837,143	5013	$\frac{365.24}{30}$ (12.174)

POPULATION, DEATHS AND DEATH-RATES PER 1000 POPULATION, CITY OF NEW YORK, PRINCIPAL CAUSES, YEARS 1898 TO 1917, INCLUSIVE.

Year.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.
Population	3,272,418	3,356,722	3,446,042	3,554,079	3,665,825	3,781,423	3,901,023	4,025,742	4,166,556	4,314,237	4,469,248	4,632,078	4,794,935	4,929,586	5,064,237	5,198,888	5,333,539	5,468,190	5,602,841	5,737,492
Total deaths	66,294	65,343	70,872	70,720	68,112	67,864	78,060	73,714	76,203	79,205	73,072	74,105	76,742	75,423	73,008	73,902	74,803	76,193	77,801	78,575
Death-rate	20.26	19.47	20.57	19.90	18.58	17.95	20.01	18.31	18.20	18.36	16.35	16.00	16.01	15.30	14.41	14.21	14.03	13.93	13.89	13.70
Total deaths under 5 years	25,499	23,801	25,836	24,256	24,388	22,044	25,542	24,539	25,777	25,794	24,141	24,519	24,268	22,242	20,978	20,711	19,530	20,291	19,967	18,265
Rate on general population	7.79	7.09	7.49	6.82	6.65	5.83	6.55	6.09	6.19	5.98	5.40	5.29	5.06	4.51	4.14	3.98	3.66	3.71	3.56	3.48
Rate, pop. under 5 yrs.	67.2	61.1	64.6	59.3	58.4	51.6	58.5	54.9	56.2	54.9	50.0	49.5	47.7	42.6	39.1	37.6	34.5	35.0	33.6	29.9
Typhoid fever	676	546	718	727	764	653	661	649	639	740	536	564	558	545	499	362	334	332	216	229
Rate	0.21	0.16	0.21	0.20	0.17	0.17	0.17	0.15	0.15	0.17	0.12	0.12	0.12	0.11	0.10	0.07	0.06	0.06	0.04	0.04
Typhus fever	1	..	..	..	..	..	....	....	....	....	....	....	....	....	....	....	1	....	1	2
Rate	0.0003	..	..	..	..	..	....	....	....	....	....	....	....	....	....	....	0.0002	....	0.0002	0.003
Malarial fever	250	167	216	195	125	90	91	53	64	69	34	40	27	38	20	13	20	11	10	10
Rate	0.08	0.05	0.06	0.05	0.03	0 02	0.02	0.01	0.02	0.02	0.01	0.01	0.006	0.008	0.004	0.003	0.004	0.002	0.002	0.002
Smallpox	1	18	12	410	310	5	7	9	6	9	1	2	5	3	2					
Rate	0.0003	0.005	0.003	0.12	0.08	0.001	0.002	0.002	0.001	0.002	0.0002	0.0004	0.0010	0.0006	0.0004					
Measles	651	587	816	449	710	508	895	520	1,145	728	972	997	785	659	671	628	560	630	490	560
Rate	0.20	0.17	0.24	0.13	0.19	0.13	0.23	0.13	0.27	0.17	0.22	0.22	0.16	0.13	0.13	0.12	0.11	0.12	0.09	0.10
carlet fever	703	533	465	1,162	940	734	851	473	491	796	1,333	786	953	741	615	507	452	291	96	120
Rate	0.21	0.16	0.13	0.33	0.26	0.19	0.22	0.12	0.12	0.19	0.29	0.17	0.20	0.15	0.12	0.10	0.08	0.05	0.02	0.02
Diphtheria and croup	1,778	1,924	2,277	2,068	2,015	2,190	2,048	1,544	1,898	1,740	1,758	1,714	1,715	1,281	1,125	1,333	1,491	1,278	1,031	1,158
Rate	0.54	0.57	0.66	0.58	0.55	0.58	0.53	0.38	0.46	0.40	0.39	0.37	0.36	0.26	0.22	0.26	0.28	0.23	0.18	0.20
Whoopingcough	716	514	584	289	606	324	197	408	367	393	188	401	294	384	287	420	279	397	349	489
Rate	0.22	0.15	0.17	0.08	0.17	0.09	0.05	0.10	0.09	0.09	0.04	0.09	0.06	0.08	0.06	0.08	0.05	0.07	0.06	0.08

Cerebrospinal meningitis	357	394	306	267	265	271	1,403	2,025	812	643	351	326	294	203	196	202	207	119	176	185
Rate	0.11	0.12	0.09	0.08	0.07	0.07	0.36	0.50	0.19	0.15	0.08	0.07	0.06	0.04	0.04	0.04	0.04	0.02	0 03	0.03
Pulmonary tuberculosis	7,724	8,015	8,154	8,135	7,569	8,020	8,512	8,535	8,955	8,999	8,869	8,643	8,692	8,790	8,591	8,601	8,918	8,825	8,411	8,825
Rate	2.36	2.39	2.37	2.29	2.07	2.12	2.18	2.12	2.16	2.09	1.98	1.87	1.81	.178	1.70	1.65	1.67	1.61	1.50	1.54
Other tuberculosis diseases	1,541	1,562	1,476	1,255	1,314	1,284	1,257	1,123	1,239	1,263	1,288	1,268	1,382	1,460	1,390	1,430	1,372	1,424	1,237	1,317
Rate	0.47	0.47	0.43	0.35	0.36	0.34	0.32	0.28	0.30	0.29	0.29	0.27	0.29	0.29	0.27	0.27	0.26	0.26	0.22	0.23
Bronchitis	1,923	1,988	1,964	1,683	1,898	1,560	1,735	1,417	1,319	1,048	819	1,051	928	877	732	. 693	601	711	813	789
Rate	0.59	0.59	0.57	0.47	0.52	0.41	0.44	0.35	0.32	0.24	0.18	0.23	0.20	0.18	0 15	0.13	0.11	0.13	0.14	0.14
Pneumonia	8,094	8,531	10,482	9,168	9,377	9,714	12,369	9,783	10,868	11,806	9,508	10,614	10,519	10,055	9,979	10,042	9,678	10,922	10,568	11,051
Rate	2.47	2.54	3.04	2.58	2.56	2.57	3.17	2.43	2.61	2.74	2.13	2.29	2.19	2.04	1.97	1.93	1.81	2.00	1.89	1.93
Diarrhea under 5 years	6,570	5,569	5,978	6,071	5,190	4,443	5,647	6,136	6,016	6,611	6,190	5,380	5,918	4,696	4,149	3,668	3,579	3,924	3,053	3,365
Rate on whole population	2.01	1.66	1.73	1.71	1.42	0.117	1.45	1.52	1.44	1.53	1.38	1.16	1.23	0.95	0.82	0.71	0.67	0.72	0.55	0.59
Rate on population under 5 years	17.3	14.3	15.0	14.9	12.4	10.4	12.9	13.7	13.1	14.1	12.8	10.9	11.6	9 0	7.7	6.7	6.3	6.8	5.1	5.5
Cancer	2,006	2,136	2,291	2,463	2,450	2,608	2,709	2,875	3,005	3,227	3,243	3,488	3,710	3,873	4,071	4,223	4,467	4,647	4,701	4,867
Rate	0.61	0.64	0.66	0.69	0.63	0.69	0.69	0.71	0.72	0.75	0.73	0.76	0.77	0.78	0 80	0.78	0.84	0.85	0.84	0.85
Bright's and nephritis	4,686	5,113	5,352	5,500	5,461	5,636	6,220	5,944	6,108	5,685	5,049	5,522	5,638	5,017	5,724	5,615	5,617	5,521	6,546	6,727
Rate	1.43	1.52	1.55	1.55	1.49	1.49	1.59	1 48	1.47	1.32	1 13	1.19	1 17	1.02	1.13	1 08	1.05	1.01	1.17	1 17
Heart disease	3,847	3,751	3,858	4,626	4,859	4,771	4,996	5,140	5,557	7,237	7,130	6,854	6,870	7,965	8,890	9,674	10,058	10,383	10,687	11,102
Rate	1.18	1.12	1.12	1.30	1.33	1.26	1.28	1.28	1.33	1.68	1.59	1.48	1.43	1.62	1.76	1.86	1.89	1.90	1.91	1.93
Puerperal dis.	568	558	711	648	642	637	727	815	763	783	698	719	761	738	676	668	679	710	653	651
Rate	0.17	0.17	0.21	0.18	0.18	0.17	0.19	0.20	0.18	0.18	0.16	0.16	0.16	0.15	0.13	0.13	0.13	0.13	0.12	0.11
Violence	3,677	3,385	3,913	4,636	3,752	4,068	5,191	4,476	4,741	4,911	4,737	4,403	4,638	5,183	4,762	4,937	4,985	4,777	5,060	5,742
Rate	1.12	1.01	1.14	1.30	1.02	1.08	1.33	1.11	1.14	1.14	1.06	0.95	1.00	1.05	0.94	0.95	0.93	0.87	0.90	1.00
Deaths under 1 year	16,770	15,381	16,640	15,467	15,526	14,402	16,125	16,522	17,188	17,457	16,231	15,976	16,215	15,030	14,289	13,780	13,312	13,866	12,818	12,568
Rate per 1000[1]	203	182	192	173	168	151	164	163	164	160	144	137	126	112	105	102	95	98	93	89

[1] 1898 to 1909 inclusive based on estimated population under one year, 1910 to 1917, based on number of births reported.

Multiply the number of deaths, 5013, by the factor obtained by dividing the number of days in the month, 30, into the number of days in the year, 365.24 (12.174), and divide the product by the number of thousands in the population, 5837.143. The resulting quotient will be 10.45 which is the death-rate per 1000 of the population for the month, and is to be interpreted to mean that if 5013 deaths occurred in every month having thirty days the annual rate would be 10.45 per 1000 of population.

Quarterly Death-rates.—Quarterly death-rates are prepared in similar manner to the weekly and monthly rates with the exception that the multiplying factor is different; if there are ninety days in the quarter then the factor will be the quotient arising from the divisor of the number of days in the year, 365.24 by the number of days in the quarters, 90, *i. e.*, 4.058.

Specific Death-rates.—In addition to the crude death-rates it is necessary to prepare death-rates of certain prominent causes of death in order to measure the effect of preventive action by public health officials. In preparing rates based on individual causes of death the procedure is the same as stated above. The table on pages 824 and 825 gives the death-rates from all causes and from several principal causes in the city of New York for a period of twenty years. As the age constitution of the population of the city has changed only slightly during that period the rates are comparable without criticism.

It is of importance upon occasion to prepare death-rates based upon age groupings of the population, especially at the age group under one year and that under five years; the table gives an example of this specific rate in the death-rates of children under five years from diarrheal diseases, and in the rates under one year of age from all causes. In order to calculate the death-rates at any certain age group the procedure is to ascertain the percentage of the age group to the whole population as given in the census reports and to apply this percentage to the estimated population for the year desired; for example, the entire population of a city by the census returns in 1910 was 220,000 and the number of children under five years was 22,000, which is equivalent to 10 per cent. of the population; if it is desired to know the number of children in the year 1917, and the estimated population was 260,000 in that year then 10 per cent. of 260,000 or 26,000 would be the estimated number of children living at that year; if the annual number of deaths among children under five years of age was 1440, then by dividing the number of deaths by the number of thousands in the estimated population of the age group the quotient will be 55, *i. e.*, 55 children out of every 1000 living at that age group died during the year.

Factors that Affect the Death-rate.—*The Effect of Sex on Mortality.*—In nearly all civilized countries there has been recorded year by year a much lower death-rate among females as compared with males; in the registration area of the United States the rate has been lower for each year irrespective of race or color. The difference has averaged

for many years about two more deaths per 1000 of the population among males. The higher mortality among the males exists at every age group of the population.

In communities in which the proportion of females to males is higher, such as health resorts in which large numbers of female servants are employed, the effect of lowering the mortality-rates is considerable. The increased mortality among males is due to several causes, such as hazardous occupations, abuse of intoxicating liquors and suicide.

The Effect of Age on Mortality.—The mortality at the extremes of life is much greater than at the intervening periods, roughly speaking, descending from 100 deaths per 1000 living under the first year of life, to a rate of 2 per 1000 at about the eleventh year of life and gradually increasing until at the seventy-seventh year the rate experienced under the first year of life is duplicated.

A community of recent growth, such as a "boom city" of the West, will contain a large percentage of individuals at ages between twenty and forty-five years, at which ages death-rates are low, with the effect that a crude death-rate results which is much below those of the eastern cities. Seattle, St. Paul and other large cities of the West have a death-rate as low as 9 or 10 per 1000 of the population, as against rates in New York, Boston and Philadelphia of 14 to 16 per 1000. The latter cities spend millions upon conservation of health of the communities, the former spend comparatively little, and the unthinking accept without question the printed statements that are circulated in reports of boards of trade that the city they represent has the lowest death rate or next to the lowest of any city in the United States. The low death-rates in these cities are due in great measure if not entirely to the favorable age grouping of the population, which makes for a low death-rate irrespective of surrounding health conditions.

Race and Nationality.—The mortality of the negro is far heavier than that of the whites. In the city of New York in 1916 the death-rate of the whites was 13.7, the colored rate 24.4, and this despite the fact that the colored population had a more favorable age distribution. The table on page 832, taken from the 1916 Annual Report of the Department of Health, clearly shows the excessive mortality among the negroes at all age groups.

The mortality of the different nationalities also varies, but not to the extent that the negro mortality varies from the white mortality. Prof. Glover, in the life tables prepared under his supervision for the Bureau of the Census, shows that the native-born have a lower mortality and a higher expectancy of life than have the foreign-born residents of the United States.

Marital Condition.—The death-rate among married males at age groups over twenty years is much lower than among single, widowed or divorced males. The death-rate among married females is slightly higher at the age group twenty to forty years than among single females —due probably to the deaths from puerperal causes among the married

—but is much lower at this and other age groups than the widowed or divorced.

Density of Population.—This, in itself, has little effect upon mortality; where the population is densely congested other conditions are usually unfavorable, as there is poverty, ignorance and dirt. The number of persons occupying a room is a far more important factor than the number of persons per acre. The room density has a very direct influence upon the prevalence of the acute infectious diseases.

Sanitation.—The sanitary conditions of a community, for obvious reasons, has a very direct influence upon the health and mortality of the residents. Where the sewage disposal is inadequate, where the water system is not properly guarded, where the handling of milk is not supervised, such diseases as typhoid and other intestinal diseases are prevalent.

Economic Conditions.—Within recent years we have come to realize that economic conditions exert a most important influence upon mortality. Where the family income is small, housing is poor, food is of poor quality and often insufficient in amount and proper medical care is lacking. In fact we realize today that the family income has a most direct bearing upon the family's health, both mental and physical; the amount of family income determines the character of the premises in which they live, the quantity and quality of their food, the sufficiency or insufficiency of their clothing, the enjoyment of wholesome pleasures, and other factors that determine the condition of health. Likewise, the worker's earnings determine whether he shall be able to accumulate sufficient savings to care for himself in the event of illness and to provide for his old age.

Hospital and Clinic Facilities.—The presence or absence of sufficient hospitals and clinics to care for the poor who are ill naturally has a most important influence upon the death-rate of a community. In large centers of population hospitals and clinics are indispensable, not only for the treatment of general surgical and medical cases, but for the isolation and treatment of persons suffering from acute contagious diseases. The provision of adequate facilities for caring for persons suffering from tuberculosis is also important. To a lesser degree, the provision of district nurses, social service, etc., affects the health of a community and consequently its mortality.

Occupation.—Occupation has a most important bearing upon mortality. There are certain occupations which, because of their inherent hazards, cause high rates of mortality among the persons engaged in them. In studying the relation of occupation to mortality, one must not lose sight of the influence of age distribution upon mortality. We need only consider the matter for a moment to realize that the ages of persons employed in different occupations vary within wide limits—*e. g.*, bankers, clergymen, professional men—have a higher average age than persons engaged in occupations that require shorter periods of preparation. Again, other occupations, because of the environment or less arduous duties, attract persons of advanced

ages. An example of the effect of age upon the mortality of occupation, is clearly shown in a study of the mortality of farmers. It will be found that the crude death-rate of farmers is far above the average for the country as a whole. But, if the mortality of the farmers is corrected for age distribution, they will be found to have a mortality below the average of the country. The determining factor of the high mortality among farmers is their advanced ages.

Birth-rate.—The birth-rate of a community affects its death-rate in the following manner: If the number of births equal the number of deaths, we have a so-called stationary population, in which the birth-rate has little influence upon the death-rate. If in such a community the birth-rate, for any reason whatsoever, increases so that it exceeds the death-rate, then during the first ten years the death-rate in that community will also be increased, because the population at the beginning of life when mortality is high has been increased. If, however, the high birth-rate continues during the next ten years, those children that have survived the first ten years of life, will have entered upon a ten-year period during which mortality is at its lowest, and the crude death-rate will consequently fall. If the birth-rate continues to exceed the death-rate, the death-rate will be forced still lower because a large number of persons are brought nto the population, who, as they reach the ages of low mortality, say from ten to forty years of age, tend to reduce the crude death-rate. If after a high birth-rate for ten years, the birth-rate again falls to its former height, the death-rate will be abnormally low because the children born during the ten years will have entered upon a period of low mortality, and as fewer children are born there will be fewer in the first ten years of life when the mortality is high. When the children born during the ten years when the birth-rate was high, enter the third decade of life, the death-rate will again commence to rise until it exceeds its former height.

Migration.—Immigration and emigration affect the mortality of a community by reason of their effect upon age distribution. Persons who migrate are usually young adults. In other words, persons who are in that period of life when the mortality is low. Therefore, it follows that if such persons emigrate from a community, the death-rate of that community will rise in proportion to the number of persons who emigrate, and it also follows that immigration for the opposite reason, that is, because it increases the number of persons in the population at the ages of low mortality, decreases the death-rate.

Non-residents.—In many communities, the non-residents exert an important influence upon the mortality. This is especially true in health resorts to which the ill flock and whose deaths are then counted against the community. In winter and summer resorts the deaths are included in the mortality of the community while they are not included among the population. In large business centers the mortality among visitors tends to raise the mortality of the community. The mortality among inmates of hospitals and other institutions

increase the mortality of the community in which the hospital or institution is located if the district from which the patients are recruited extends beyond the boundaries of the community itself, as is frequently the case in State hospitals, institutions for the insane, sanitoria for the treatment of tuberculosis and colonies for alcoholics and epileptics. Similarly, private institutions, because of their reputation for the successful treatment of certain diseases, attract large numbers of patients from other communities.

The problem of treating deaths of non-residents is a rather difficult one, and will only be satisfactorily solved when there is a nation-wide system of exchange of non-resident deaths whereby the deaths in one community of residents of another community will be charged back to the community wherein the deceased had their usual or legal residence.

In the city of New York the custom is to include in the mortality of the city the deaths of all non-residents. Those who die of accidents met with in the city, and of acute diseases contracted since residence in the city began, such as lobar pneumonia and the acute infectious diseases, are properly included in the death lists; while the deaths of non-residents caused by chronic conditions, the duration of which was greater than the length of residence, might with propriety be excluded from the mortality of the city in the event of a correction being made of the death-rate for this factor.

Infantile Mortality.—Infant mortality is probably one of the most important subjects in the entire field of vital statistics: (1) Because children born into the world replenish the population depleted by death; (2) because from the infants are recruited the citizens of the next generation, and as their mortality is an index of their morbidity it stands to reason that if morbidity is high among infants their resistance to attacks of disease in the future will be lessened and they will enter upon life with a serious physical and perhaps mental handicap. Infant mortality is of further importance because it is a most reliable index of the sanitary conditions of a community and the progressiveness of its health work, and when the infant mortality-rate is computed upon the number of living births reported during the year, it is, if registration of births is complete, an absolute index of conditions because the rate is not affected by the distance in time of the year under consideration from the census year; in other words, the infant death-rate is computed upon an accurate enumeration of the infant population and not upon an estimate.

In the discussion of the errors in the census enumeration, we called attention to the fact that the enumeration of infants under one year of age at a census was almost always inaccurate because of the tendency of parents and others to state the age of infants under one year of age as one year. For this reason it is inadvisable to compute an infant mortality-rate upon the population under one year as determined at a census; if based on this latter it will serve only as an approximation of the true infant mortality-rate.

Factors which Affect Infant Mortality.—*Prenatal Conditions.*—(*a*) The conditions under which the mother lives during her pregnancy have been shown conclusively to affect the health and vitality of her child and frequently cause premature birth. We refer particularly to factory employment, undernourishment and poverty. (*b*) Diseases of the parents such as syphilis, tuberculosis, epilepsy and alcoholism.

Postnatal Conditions.—Ignorance of the parents as to the proper care of infants. Industrial and economic conditions which necessitate the mother working during the period of lactation, thereby depriving the child of its mother's undivided attention and creating the necessity of partially or completely feeding the infant artificially and of entrusting their care to inexperienced children and neighbors.

Poverty.—Which necessitates an unwholesome environment and which makes for insufficient and improper food for the mother during pregnancy and lactation and for the child after the period of lactation.

Overcrowding.—Overcrowding itself has little effect upon infant mortality. If the buildings are up to date, sanitary conditions good, rooms light, facilities for cleanliness sufficient, there is no reason why overcrowding, unless, carried to an extreme degree, should have any effect on infant mortality except upon incidence and mortality of the acute contagious diseases. It is conceivable that where a number of persons are living in close contact the possibility of spreading acute contagious diseases is increased in proportion to the degree of overcrowding.

Social Conditions.—Which at present cause mothers to artificially feed their young in order that they may devote more time to social functions and the pursuit of amusement. In this connection it is interesting to note that the death-rate of infants of native mothers in moderately comfortable financial circumstances is higher than among the uneducated and very poor foreigners who nurse their young.

Overage and Underage of Parents.—When the parents are either too young or too old the vitality of their offspring is usually low.

Illegitimacy.—The death-rate of illegitimate infants is from two to four-fold that of children born in wedlock, and is due to the difficulty surrounding their gestation and birth and the tendency, if indeed not the necessity, of entrusting them to foundling asylums.

High Infant Death-rate.—In countries where the birth-rate is high, the infant death-rate is usually correspondingly high, but the high mortality is rather the cause than the effect since the death of an infant shortens the period of its mother's lactation and predisposes to immediate reimpregnation; frequent impregnation lowers the vitality of the mother and forms a "vicious circle."

Immediate Causes of Infant Deaths.—The immediate causes of infant deaths are: (1) Respiratory diseases, bronchitis and pneumonia. The mortality of these diseases is greatest during the winter months, and is particularly high among the Italians and negroes, and is usually greater in the colder than in the warmer climates. (2) Diarrheal diseases, the mortality of which is high during the summer

DEATHS FROM ALL CAUSES BY SEX, AGE AND COLOR. DEATH-RATE PER 1000 POPULATION ESTIMATED AT DIFFERENT AGE GROUPS, CITY OF NEW YORK.

Age, years.	Estimated population, 1916.						Total deaths, all causes.			Total deaths all causes.			Death-rate per 1000 population estimated at different age groups.						Increase in mortality of negroes over white.		
	White.			Negro.			White.			Negro.			White.			Negro.					
	Males.	Females.	Both sexes.	Males.	Females.	Both sexes.	Males.	Females.	Both sexes.	Males.	Females.	Both sexes.	Males.	Females.	Both sexes.	Males.	Females.	Both sexes.	Males.	Females	Both sexes
Under 1	68,990[1]	66,105[1]	134,095[1]	1,347[1]	1,171[1]	2,518[1]	6,922	5,404	12,326	271	218	489	100.3	81.7	90.9	201.0	186.1	194.2	+100.7	+104.4	+103.3
Under 5	296,300	291,600	587,900	3,816	4,080	7,896	10,726	8,537	19,263	375	325	700	36.1	29.3	32.7	98.3	79.6	88.5	+62.2	+50.3	+55.8
5 to 9	254,900	253,750	508,650	2,825	3,206	6,031	1,027	864	1,891	29	28	57	4.0	3.4	3.7	10.3	8.7	9.5	+ 6.3	+ 5.3	+ 5.8
10 to 14	245,000	245,000	490,500	2,627	3,089	5,716	506	462	968	22	17	39	2.0	1.9	2.0	8.4	5.5	6.8	+ 6.4	+ 3.6	+ 4.8
15 to 19	250,500	279,800	530,300	3,122	4,255	7,377	780	726	1,506	29	30	59	3.1	2.6	2.8	9.3	7.0	8.0	+ 6.2	+ 4.4	+ 5.2
20 to 29	577,500	599,950	1,174,450	14,075	18,477	32,552	2,782	2,416	5,198	177	163	340	4.8	4.0	4.4	12.6	8.8	10.4	+ 7.8	+ 4.8	+ 6.0
30 to 39	474,100	442,200	916,300	12,737	13,232	25,959	4,356	2,809	7,165	250	203	453	9.2	6.3	7.8	19.6	15.3	17.4	+10.4	+ 9.0	+ 9.6
40 to 49	331,170	306,950	648,120	6,344	6,706	13,050	5,650	3,541	9,191	210	160	370	17.0	11.5	14.2	33.1	23.8	28.3	+16.1	+12.3	+14.1
50 to 59	184,370	178,200	362,570	2,527	3,030	5,557	6,037	4,171	10,208	151	127	278	32.7	23.4	28.1	59.7	41.9	50.0	+27.0	+18.5	+21.9
60 and over	122,930	142,840	265,770	1,336	2,039	3,375	9,570	10,124	19,694	151	181	332	77.9	70.8	74.1	113.0	88.8	98.4	+35.1	+18.0	+24.3
Total	2,744,700	2,743,392	5,488,092	49,560	58,290	107,850	41,434	33,648	75,082	1,394	1,234	2,628	15.1	12.2	13.7	28.1	21.2	24.4	+13.0	+ 9.0	+10.7

[1] Total births reported.

months, and among bottle-fed infants. (3) Congenital diseases and malformation—the mortality from these diseases has changed but little in the past, whereas the mortality of the other diseases of infancy have been gradually forced downward. The table on page 832, taken from the yearly report of the New York City Health Department, graphically presents this fact. The death-rate from the congenital diseases is highest among the negroes and among the children of native white mothers. The contagious diseases play but a relatively unimportant part in infant mortality during the first six months; after the sixth month susceptibility to these diseases increases rapidly. There is a direct relation between room overcrowding and the incidence and mortality of these diseases. (4) Syphilis *per se* causes but comparatively few deaths of infants. It, however, gives rise to a multitude of ills and renders infants susceptible to the other diseases of childhood. The mortality of syphilis is probably purposely hidden by physicians who report deaths of infants from this cause as prematurity, marasmus and inanition.

During the past fifteen or twenty years the death-rate among infants has been reduced more than half in New York City. In a great measure the reduction has offset the decline in the births, so that despite the fact that fewer babies are born now than fifteen or twenty years ago, the proportion of infants that survive the first year of life is approximately the same as formerly. The infant welfare work that has been carried on during this time has resulted in the maintenance of the same number of infants at one year of age from a much smaller number of children born; and it is reasonable to suppose that the infants today who reach the first year of life are healthier and stronger and enter upon the remainder of their lives with fewer physical handicaps than did the first-year survivors of fifteen years ago.

Registration.—The first record that we have of compulsory registration was in Rome about the time of Servius Tullius. The purpose of this registration is not disclosed. In England the office of the Registrar-General was established in 1836, and registration by the civil authorities began as a result of an Act of Parliament on July 1, 1837. In this country the first dependable statistics of deaths were collected in Massachusetts and in New Jersey. In the city of New York the first mortality returns were made in 1795 and consisted of a list of the persons who died during an epidemic of yellow fever in that year.

Registration of deaths began in the city of New York in 1798, and with the exception of a few years in the first decade of the nineteenth century has continued down to the present day. In the early days the registration was not complete for the reason that there was no satisfactory system of issuing permits for burial. The following is an extract from the report of the Metropolitan Board of Health in 1866:

"The registration of deaths in New York City dates back to the year 1803. Cemetery records and the return of certificates of death,

through the cemetery keeper or sexton, until within the last twenty-three years, supplied the information of deaths to the City Inspector. Until the adoption of new regulations last spring serious irregularities prevailed. The frequent application for transcripts of death records which had never been registered led to inquiries that confirmed and solved the question of incompleteness in the public registry. The Metropolitan Board of Health has heartily sustained its Bureau of Vital Statistics in maintaining that 'considered physically, the main object of a correct civil registration of births, deaths, marriages is to aid in disclosing the causes of disease; that considered legally, the object is to provide means of tracing descent and proving personal identity, and that considered politically, it is to assist the government in arriving at correct conclusions with regard to measures of internal economy, employment, etc.'"

So that it was not until a demand for transcripts of death records brought home to the authorities the incompleteness of registration that steps were taken to secure a record of every death that occurred in the city. The following quotation, also from the Metropolitan Report of 1866, is of sufficient interest to quote:

"In no other city in the world did greater need of such systematic and rigid rules exist. I am happy to state that no opposition has been shown to this rigorous system, though until the Metropolitan Sanitary Board ordered it into operation, the city inspectors' permits were to be had for the asking—ready signed and in quantity—at the shops of various undertakers and medicine vendors in different sections of New York City. Such a premium on the daily violation of the statute regarding the interment and the sanctity of human remains was not to be tolerated. A Board of Health and its Bureau of Vital Statistics could not allow that vicious system to continue for an hour. The Metropolitan police quickly gathered up and brought to headquarters all those unguarded burial permits. There were other and very gross evils connected with the custody and registration of the dead, which were promptly corrected."

Until a permanent Federal Bureau of the Census was established the only means that the federal government had of securing mortality statistics was by incorporating in the census a query as to the names, ages, civil conditions, etc., of persons who had died in each household during the year prior to the last census. It is apparent that such a method of collecting mortality statistics was almost useless because of the tendency of persons to fail through forgetfulness or design to report to the enumerators deaths in their household. Usually, upon the death of the head of the family, the household broke up and the members then living apart, each reported the death of the head of the family thus causing the duplication of records, or each depending upon some other member of the family to report the death omitted to report, thus causing incompleteness.

Registration Area.—The Federal Bureau of the Census established in 1880 a registration area to which States and cities in which registra-

tion of deaths was approximately complete were admitted. Certificates of death filed in the registration area were copied by persons in the employ of the Federal Bureau and forwarded to the Central Office in Washington for tabulation. The following paragraph, taken from the published report of the ninth census, 1870, is of interest:

"The dimensions attained by the life insurance institutions within the past few years make it peculiarly a matter of regret at the present time that the census should not afford the data for determining with absolute precision and certainty the death-rate of the country, whether in the aggregate or by classes of population. This can only be done by national scheme of registration, stringently enforced by penalties."

Dr. Cressy L. Wilbur, formerly Chief Statistician, Division of Vital Statistics, Bureau of the Census, deserves unstinted praise for the progress made in the United States toward accurate and complete registration of deaths. He was untiring in his efforts and the success that he had will ever remain a monument to his memory.

Method of Collecting Mortality Statistics. — The source of the statistical data of death is obtained from the reports filed by physicians with the statistical office. These reports, known as certificates of death, call for information as to the name of the disease, place of death, sex, age, color, civil condition, occupation, birthplace, parents' names and birthplaces, cause of death, usual address and in the majority of cases, duration of residence at the place of death, and if foreign-born, duration of residence in the country. Model certificates have been prepared by the Bureau of the Census and adopted by the States and cities in the registration area.

As we have seen in the early registration of deaths in New York City, registration was incomplete until provision was made in the law that no human remains be disposed of without a permit issued by an authorized representative of the Department of Health. The usual procedure in New York City is as follows: The physician is allowed thirty-six hours to file a proper certificate with the authorities. In cases of acute infectious diseases certificates must be filed immediately.

Upon the death of a patient the physician in attendance fills out and files with the Department of Health a certificate of death. The undertaker applies to the Department of Health for permit for burial, and upon the presentation of satisfactory evidence that he has been engaged by the relatives of the deceased a permit for burial or cremation is granted. The permit specifies the cemetery or crematory and the date of burial or cremation accompanies the remains of the deceased to the place of burial or cremation to be surrendered to the person in charge of the crematory or cemetery. Within a specified time after burial or cremation the superintendent of the cemetery or crematory is required to return all permits received since the date in which he made his last return to the office of the Bureau of Records of the locality in which the crematory or cemetery is located. At the present time there is no system of clearing returned permits by the different

cities and States. While such a nation-wide system would entail considerable expense there is no doubt that it would be of value. Where permits have been altered or in cases where they are not returned investigations are made and if the evidence justifies it complaints against the keepers of the cemeteries or crematories are forwarded to the corporation counsel for prosecution.

Causes of Error in Data Contained in Certificates of Death. — Physicians in order to have the privilege of signing death certificates must be duly licensed and are required to register their signatures with the burial permit office of the local Bureau of Vital Statistics, that is, the Bureau of Vital Statistics in the locality where they intend to practice. The purpose of such registration is to enable the health officer or his representative to verify the signature of the physician upon every certificate of death submitted for the purpose of obtaining a burial permit. The importance of this requirement is so apparent that it need not be further discussed.

Certificates of death should be filled out *in toto* by the attending physician. If undertakers are permitted to fill out certificates in so far as they relate to the personal and family history of the deceased, there is the temptation in cases where this information is difficult to obtain to substitute fictitious data. The law should provide a penalty for wilfully filing false reports. Unintentional errors are frequently made in certificates of death, especially in cases where the physician is compelled to obtain the information from someone not closely associated with the deceased.

From a statistical standpoint the data of the occupation of the deceased contained in certificates of death is not always reliable. There are many reasons for this; perhaps the most important one is that the importance of this information has not been fully realized by health officers, and they in consequence have not insisted upon a specific statement of the occupation of the deceased. Another frequent cause is that in death certificates of old persons who retired from active employment prior to death no occupation is given. Nevertheless, the effect of their occupation prior to retirement may have had an important bearing upon their last illness. Again, occupation may be stated in such a way that it throws very little light upon the hazards to which the deceased was subjected. Still, again, there are persons who prior to death suffered from a chronic disease, such as pulmonary tuberculosis, and were compelled because of their illness to give up their usual occupation and seek one less arduous. It is evident in such cases that the last occupation of the deceased had little or no bearing upon the cause of death, whereas the usual occupation may have been an important factor in the etiology of the disease that caused death. In order to overcome as far as possible these shortcomings in the statement of occupations of deceased persons the model certificate of death calls for the particular kind of work the deceased performed, as well as a specific statement of the industry in which the deceased was employed.

The cause of death is at times unreliable. In coroners' cases where autopsies have not been performed the importance of making post-mortem diagnosis without autopsy is apparent, especially in those cases in which a satisfactory history is not obtainable. There are many cases in which even expert clinicians are unable during the life of the patient to correctly diagnose the cause of illness. There is, therefore, in all cases where diagnoses are based upon clinical findings, a percentage of error. Recently several pathologists have endeavored to show the unreliability of mortality statistics by comparing clinical diagnoses with autopsy findings. At first glance these studies create apparently a well-founded doubt as to the usefulness of mortality statistics based upon death returns, but if we bear in mind the fact that certain diseases are and have been for many years possible of positive diagnosis, as for example, many of the acute infectious diseases, that the physical signs of other diseases are unmistakable, and that in still other diseases bacteriological and other laboratory examinations are frequently employed as aids to diagnosis of the causes of death, we can take a more optimistic view of the situation and feel that after all mortality statistics are, on the whole, dependable. Furthermore, it is a well-known fact among statisticians that in dealing with large numbers errors tend to correct themselves. That is to say, that if a certain percentage of errors are made in diagnosing one disease as another, a similar percentage of errors will be made conversely.

Recently a committee of the American Public Health Association examined the causes of death given in the International Classification of Diseases and Causes of Death with the purpose of determining what diagnoses should be accepted as reliable without autopsy, and those that should be accepted as reliable only after autopsy. It was proposed in addition to the routine tabulations that a tabulation be made in which the reliable and unreliable diagnosis should be separated. The practicability of this scheme, however, is questionable at present. In the first place, it will be years before sufficient data will have been accumulated for comparison. In the second place, there are numerous practical difficulties that will be encountered and must be satisfactorily solved, *e. g.*, the committee decided that valvular heart-disease was a diagnosis that may be accepted without autopsy, but it is evident if this diagnosis is returned by coroner's physician or a medical examiner without autopsy and without a statement from a physician who had examined the deceased during life and made such a diagnosis then this assignment would be absolutely valueless, and could not be placed among the reliable causes of death; in the third place the difficulty in obtaining a unanimity of action by local registrars.

Much valuable additional data as to the cause of death can be obtained by directing letters of inquiry to physicians reporting unsatisfactory causes of death, as for example, where the cause of death is returned as apoplexy without underlying cause or cancer without a statement of the location.

The following is the form letter which in the city of New York is sent physicians who in their reports of deaths fail to give sufficient information for statistical purposes:

BUREAU OF RECORDS.

CERTIFICATE NO.....

NEW YORK.....192

DEAR DOCTOR:

Will you kindly forward to this office, at your earliest convenience, the following information in regard to the death of

.....

who died at.....on.....191...

.....

If you will consult the enclosed list of indefinite causes of death, it may help to make clear what further information is required.

This information is sought only for statistical purposes and will not be made public.

Very respectfully

.....M.D.
Asst. Registrar of Records.

This sheet is to be returned. Use space below for answer.

.....

If more space is required use other side of this sheet.

DEPARTMENT OF HEALTH OF THE CITY OF NEW YORK—
BUREAU OF RECORDS.

Unsatisfactory Terms used in Certifying the Cause of Death.

Undesirable Terms. (It is understood that the term criticized is in the *exact form* given below, *without further explanation or qualification.*)	Reason Why Undesirable and Suggestion for More Definite Statement of Cause of Death.
"*Abortion*" *and* "*Miscarriage*" .	The period of gestation and the cause of the abortion or miscarriage should be stated clearly upon the certificate. If the abortion was induced because of any disease from which the mother may have been suffering, the disease should be stated upon the certificate of death. If the abortion or miscarriage was criminally induced, the coroners' office must be notified, if possible, a sufficient length of time before death, to permit of the coroner's securing an antemortem statement from the patient.
"*Abscess*"	May be tuberculous, gonorrheal, from appendicitis etc., or relate to any part of the body. The return is worthless. State *cause* (in which case the fact of "abscess" may be quite unimportant) and *location.*

Undesirable Terms. (It is understood that the term criticized is in the *exact form* given below, *without further explanation or qualification.*)	Reason Why Undesirable and Suggestion for More Definite Statement of Cause of Death.
"*Apoplexy*"	Is the terminal incident in the course of some other disease, *e. g.*, arteriosclerosis, nephritis, heart disease, syphilis, alcohol and other poisoning, leukemia, etc.? The primary cause of death is required for statistical purposes. When a history of syphilis is obtained, that fact should be stated upon the certificate or in an accompanying letter.
"*Asthma*"	State whether secondary to heart or kidney lesion.
"*Atrophy*," "*Debility*," "*Decline*," "*Exhaustion*," "*Inanition*," "*Weakness*"	Frequently cover tuberculosis and other definite causes. Name the *disease causing* the condition.
"*Bronchitis*"	Was it acute or chronic? If it extended to pneumonia the death should be reported as bronchopneumonia. Chronic bronchitis frequently disguises pulmonary tuberculosis. Was the death caused by consumption?
"*Cancer*," "*Carcinoma*," "*Sarcoma*," etc.	In all cases the *organ or part first affected by cancer* should be specified. Also state whether an operation was performed and whether it was radical or palliative.
"*Cardiac Dilatation*"	This term has become worthless because of the careless use of the term when terminal paralysis of the heart is meant. The term should not be used unless there was a true dilatation of the heart.
"*Cerebral Hemorrhage*," "*Intracranial Hemorrhage*," "*Infracranial Hemorrhage*" . . .	Cerebral hemorrhage may be the final manifestation of heart, kidney or other disease, or the result of violence. It should be made clear on the certificate if antecedent cause existed; if traumatic, the nature of the trauma should be stated.
"*Congestion*," "*Congestion of bowels*," "*Congestion of brain*," "*Congestion of kidneys*," "*Congestion of lungs*," etc. . . .	Alone, the word "*congestion*" is worthless, and in combination it is almost equally undesirable. If the disease amounted to *inflammation*, use the proper term (pneumonia, nephritis, enteritis, etc.); merely passive congestion should not be reported as a cause of death when the primary disease can be ascertained.
"*Convulsions*"	Simply a symptom of disease such as scarlet fever, nephritis, gastro-enteritis, pneumonia, etc. Certificates will be returned for more definite statements as to the cause of the convulsions.
"*Croup*"	"*Croup*" is a most pernicious term from a public health point of view, is not contained in any form in the London or Bellevue Nomenclatures, and should be entirely disused. Write *diphtheria* when this disease is the cause of death.

Undesirable Terms. (It is understood that the term criticized is in the *exact form* given below, *without further explanation or qualification.*)	Reason Why Undesirable and Suggestion for More Definite Statement of Cause of Death.
"*Dropsy*"	"*Dropsy*" should never be returned as the cause of death without particulars as to its probable origin. Dropsy is only a symptom of diseases of the heart, liver, kidneys, etc., and the disease which caused the dropsy and death should be stated.
"*Eclampsia*"	This term simply means convulsions. State the cause of the convulsions, whether puerperal.
"*Erysipelas*"	State whether it was of traumatic origin or not. When traumatic, the exact nature of the trauma should be stated, as it is frequently necessary to refer such cases to the coroner's office for investigation.
"*Gastritis*," "*Acute indigestion*"	Frequently worthless as a statement of the actual cause of death; the terms should not be loosely used to cover almost any fatal affection with irritation of stomach.
"*Heart disease*," "*Heart trouble*," even "*Organic heart trouble*" .	Some cavil at the probable correctness of such returns, and it is better to state clearly the exact form of the cardiac affection, as *mitral regurgitation, aortic stenosis*, or even as *valvular heart disease*, rather than to use the less precise language.
"*Heart failure*," "*Cardiac weakness*," "*Cardiac asthenia*," "*Paralysis of the heart*," etc. . .	"*Heart failure*" is a recognized synonym, even among the laity, for ignorance of the cause of death on the part of the physician. Certificates will not be accepted which give any of these modes of dying as the cause of death.
"*Hemorrhage*," "*Hemoptysis*" .	Frequently mask tuberculosis deaths from injuries (traumatic hemorrhage), *puerperal hemorrhage*, or hemorrhage after operation for various conditions. *Name the disease causing death* in the course of which the hemorrhage was an incident.
"*Hydrocephalus*"	Was it congenital or was it tuberculous meningitis?
"*Hysterectomy*"	See Operation.
"*Inanition*," "*Infantile atrophy*," "*Infantile marasmus*" . . .	These are pernicious terms and responsible for a multitude of worthless certificates. Whenever possible, the deaths causing them should be stated. Whether "syphilis," "tuberculosis," "cholera infantum."
"*Infantile paralysis*"	This term is sometimes used for paralysis of infants caused by instrumental delivery, etc. The importance of the disease in its present endemic and epidemic prevalence in the United States makes the exact and unmistakable expressions *acute anterior poliomyelitis* or *infantile paralysis* (*acute anterior poliomyelitis*) desirable
"*Malignant*," "*Malignant disease*"	Should be restricted to use as qualification for neoplasms; see Tumor.
"*Marasmus*"	This term covers a multitude of worthless returns, many of which could be made definite and useful by giving the name of the disease causing the "maramus" or wasting. It has been dropped from the English Nomenclature since 1885 ("Marasmus, term no longer used"). The Bellevue Hospital Nomenclature also omits this term.

Undesirable Terms. (It is understood that the term criticized is in the *exact form* given below, *without further explanation or qualification.*)	Reason Why Undesirable and Suggestion for More Definite Statement of Cause of Death.
"*Meningitis*," "*Cerebral meningitis*," "*Cerebrospinal meningitis*," "*Spinal meningitis*"	Only two terms should ever be used to report deaths from *cerebrospinal fever, synonym, epidemic cerebrospinal meningitis,* and they should be written as above and in no other way. It matters not in the use of the latter term whether the disease be actually *epidemic* or not in the locality. A single sporadic case should be so reported. The first term (*cerebrospinal fever*) is preferable because there is no apparent objection to its use for any number of cases. No man can intelligently classify such returns as are given in the margin. Mere terminal or symptomatic meningitis should not be entered at all as a cause of death; name the disease in which it occurred. *Tuberculous meningitis* should be reported as such.
	When meningitis results from trauma, the exact nature of the trauma should be stated, as it is found necessary to refer many such cases to the coroner.
"*Nephritis*"	"*Nephritis*" is frequently a complication of an acute infectious disease. If such is the case it should be made clear in the certificate.
"*Old Age*"	This is not a satisfactory return; the influence of age is shown by the statement of age in years, months and days; to this, the statement of old age as the cause of death adds nothing of value, and the disease to which the old person succumbs must be stated.
"*Operations*," "*Surgical operation*," "*Surgical shock*," "*Amputation*," "*Hysterectomy*," "*Laparotomy*," etc.	All these are entirely indefinite and unsatisfactory —unless the surgeon desires his work to be held primarily responsible for the death; always state the disease, or condition, which made the operation necessary.
"*Paralysis*," "*General paralysis*," "*Paresis*," "*General paresis*," "*Palsy*," etc.	The vague use of these terms should be avoided, and the precise form stated, as *acute ascending paralysis, paralysis agitans, bulbar paralysis,* etc. Write *general paralysis of the insane in full,* not omitting any part of the name; this is essential for satisfactory compilation of this cause. Distinguish *paraplegia* and *hemiplegia;* and in the latter, when a sequel of *apoplexy or cerebral hemorrhage,* report the primary cause.
"*Peritonitis*"	The cause should always be stated. Was it tuberculous or a complication of some other morbid condition? Was it secondary to gastric ulcer, intestinal ulcer (typhoid, etc.) or metritis (puerperal or otherwise)? Was it traumatic, if so state exact nature of trauma. When peritonitis is puerperal that fact should be made clear in the certificate, specifying also whether it followed a full term labor or miscarriage or abortion; if either of the latter two, the cause thereof should be stated.
"*Phlebitis*"	What was the cause, was it puerperal?
"*Puerperal Diseases*"	Whenever death results within one month after labor, or from a disease secondary to labor, that fact should always be stated in the certificate.

Undesirable Terms. (It is understood that the term criticized is in the *exact form* given below, *without further explanation or qualification.*)	Reason Why Undesirable and Suggestion for More Definite Statement of Cause of Death.
"*Pneumonia,*" "*Typhoid pneumonia*"	Pneumonia without qualification should never be returned as the cause of death. It should be clearly stated as either bronchopneumonia, lobular pneumonia, lobar pneumonia or croupous pneumonia. The term "typhoid pneumonia" should never be employed. State clearly whether it was typhoid fever with complicating lobar or bronchopneumonia. When pneumonia occurs as a complication of some other disease, the primary disease should be reported: As measles followed by bronchopneumonia, influenza, pneumonia. When pneumonia follows upon an operation, the condition for the relief of which the operation was performed, should be stated. Hypostatic pneumonia is merely a terminal condition, and should not be reported as the cause of death. State the disease that caused death.
"*Ptomaine poisoning,*" "*Autointoxication,*" "*Toxemia,*" etc. .	These terms are used very loosely and it is impossible to compile statistics of value unless greater precision can be obtained. "Ptomaine poisoning" should be restricted to deaths resulting from the development of putrefactive alkaloids or other poisons in food, and the food should be named, as *ptomaine poisoning* (*mussels*), etc. Such terms should not be used when merely descriptive of conditions arising in the course of diseases, but the *disease causing death* should alone be named.
"*Rheumatism*"	State whether acute or chronic. If chronic rheumatism, note any of organic diseases of the heart, or other organs resulting therefrom.
"*Statement of Operation*" . . .	The Department desires to obtain information as to whether an operation was performed in all cases of deaths reported from the different forms of cancer, appendicitis and other operable diseases. Kindly state, therefore, whether an operation was performed, and, if possible, whether it was radical or palliative.
"*Septicemia*"	The cause should be always stated and if the result of traumatism, the exact nature of the trauma specified. In women of child-bearing age it is necessary to state whether the septicemia was puerperal or not. If puerperal, did it follow a full-term labor or abortion? If a miscarriage or abortion, what was the cause thereof?
"*Tuberculosis*"	The organ or part of the body affected should always be stated, as *tuberculosis of the lungs*, *tuberculosis of the spine*, *tuberculous meningitis*, *acute general miliary tuberculosis*, etc.
"*Tumor,*" "*Neoplasm,*" "*New growth*"	These terms should never be used without the qualifying words *malignant*, *non-malignant*, or *benign*. If malignant, they belong under *cancer*, and should preferably be so reported, or under the more exact terms *carcinoma*, *sarcoma*, etc. In all cases the *organ or part affected* should be specified.
"*Uremia*"	Name the *disease causing death.*

Acknowledgment is made to the Federal Census Bureau for much of the above subject-matter which has been taken from its latest manual.

In conjunction with this letter a second form, a list of undesirable returns, is also sent. Upon the return of the query by the physician the original assignment of the cause of death is revised by the statistical office.

Undoubtedly the diagnoses given in certificates of death today are more accurate than were those given in certificates of death in years gone by, and as time goes on the cause of death as given in certificates will become more and more accurate. This fact does not justify us in discarding all mortality statistics. On the contrary, they have been of the greatest value in public health work and form the very basis of insurance. There is one precaution, however, that should be observed when studying mortality statistics, especially if the study extends back over a number of years, and that is to examine the mortality of diseases in groups rather than of separate diseases, *e. g.*, it would be unwise to base any conclusions on tabulation of the mortality statistics of apoplexy because in recent years physicians have, to a greater extent than heretofore, certified the primary condition usually arteriosclerosis, nephritis or heart disease, of which the apoplexy was but a closing incident. But if we consider the entire group consisting of apoplexy—diseases of the arteries, heart disease and nephritis—we will be able to draw very definite conclusions that will not be open to criticism by even the most skeptical.

Before attempting to compare the mortality of the remote past with that of the immediate past we should carefully go over the ground in order to determine what influences have been exerted upon the reported mortality of certain diseases by changes in method of assignment, by more intensive querying of physicians, by improved methods of diagnoses, etc., and where, because such influences have been operative, separate causes of death are found to be unreliable for comparison, we should select groups of diseases in order that we may without fear of criticism draw deductions from the accumulated data. A note of warning should be sounded as to the usefulness of studies made of such causes of death as syphilis, gonorrhea and alcoholism because of the hesitancy on the part of physicians to report such diseases as the real cause of death. In fact, only among the free hospital patients is it usual for physicians to report such diseases as causes of death.

In Switzerland this difficulty has been overcome in a measure by a dual system of reports. Briefly, this system consists of two reports—the first which contains the family and personal history of the deceased and is used for all legal purposes, and the second report which is filed by the attending physician without the name of the deceased or other information that would identify the person to whom it refers and which contains all the information required for statistical purposes.

International Classification of Diseases and Causes of Death.—It is of primary importance that statistics be uniform. Until rather recently almost every country tabulating statistics had a classification of its own, and while such classifications answered all local purposes,

they prohibited the comparison of statistics of one country with those of another. Indeed, as late as 1893 no two countries in the world employed precisely the same forms and methods of statistical classification of causes of death. The lack of such uniformity rendered statistical results incomparable.

At the session of the International Statistical Institute held in Chicago, in 1893, Dr. Jacques Bertillon presented a draft of the classification now known as "The International Classification of Causes of Death." The classification proposed by Dr. Bertillon was adopted by several countries, and in 1901 was adopted by the Bureau of the Census, the Health Department of the city of New York and the statistical offices of a few other cities. In 1911 the Registrar-General of England and Wales adopted the International Classification, so that at present many of the countries of the world are using the International Classification; among those not using it are Germany, Austra, Hungary, Switzerland and Japan.

The International Classification is nothing more than a complete list of all diseases and causes of death grouped under one hundred and eight-nine titles. It lays no claim to being ultra-scientific, its purpose being to supply a practical working classification that can without derangement and consequent loss of comparability be brought up to date from time to time. The diseases and causes of death given in the International Classification are divided into several large groups:

1. General diseases.
2. Diseases of the nervous system and the organs of special senses.
3. Diseases of the circulatory system.
4. Diseases of the respiratory system.
5. Diseases of the digestive system.
6. Non-venereal diseases of the genito-urinary system and annexia.
7. The puerperal state.
8. Diseases of the skin and cellular tissue.
9. Diseases of the bones and the organs of locomotion.
10. Malformation.
11. Early infancy.
12. Old age.
13. External causes.
14. Ill-defined diseases.

In assigning causes of death under this classification the procedure is for the assigning officer to determine which was the primary or the most important cause if two or more causes are stated upon the certificate of death. This cause of death is given first place in the assignment and the other diseases or conditions are assigned in the order of their importance as complications. The following are several examples of the method of classification: If the death is reported as due to measles and bronchopneumonia preference is given to the contagious disease, measles, and pneumonia is assigned as the complication. If two contagious diseases are given as the cause of death, *e. g.*, scarlet fever and diphtheria, scarlet fever as the more fatal disease

is given the preference and the death is assigned to that cause with diphtheria as the complication. It is a general rule that when two diseases are given as the cause of death, one of which is an infectious disease, the preference be given to the infectious disease, *e. g.*, pulmonary tuberculosis and organic heart diseases, preference is given to pulmonary tuberculosis. If a person while suffering from some disease, even though it be usually fatal in its termination, meets with an accident or is murdered or commits suicide, preference is given to the accidental cause, or to homicide or suicide. It is unnecessary in this chapter on statistics to give further rules for assigning joint causes of death as they will be found in the manual of the International Classification issued by the Bureau of the Census, copies of which may be obtained upon request. The Bureau of the Census also publish a manual on joint causes of death. While this list of assignments of joint causes is helpful, particularly when the assigning is entrusted to lay persons, it does not in all cases give best results because frequently physicians in their certificates will give some clue as to the more important cause of death, and it is not too much to say that mortality statistics based upon assignments made by a competent physician judging each case on its own merits are of more value than those based upon a routine procedure.

Mechanical Methods of Tabulating.—Where the number of certificates of death, births, marriages handled are small the usual method is to make the tabulations by hand. Where, however, the volume of work is sufficiently large to warrant the expense of installation a great saving in time and labor and improvement in accuracy is obtained by use of electric sorters and counters. The system was originally devised by Hollerith, after whom the first sorters and counters were named. At the present time there are several firms manufacturing machines of this kind, the best known being the Hollerith and the Powers machines.

Morbidity Statistics.—While morbidity statistics are the most neglected branch of vital statistics, they are, nevertheless, perhaps the most important. Morbidity, to a greater extent than mortality, determines the prosperity of a community. Mortality statistics shed light upon the cases of illness that terminate fatally. They shed no light upon the far more numerous cases of illness wherein the human organism is seriously and ofttimes permanently impaired, its efficiency lowered and its life shortened. The mortality statistics further shed no light upon the amount of suffering caused by sickness and the financial loss occasioned to individuals and families in the community—for the most part by preventable causes. The reason that morbidity statistics have been neglected is the difficulty and expense attending their collection; but as the death-rate gradually reaches that point at which it must of necessity become more or less stationary, the importance of securing morbidity statistics looms greater and greater, and for that reason there have been concerted efforts made to accumulate morbidity statistics that will be of value

in public health and social work. Likewise, the advent of such social and economic legislation as employers' liability insurance and compulsory illness insurance makes the collection and tabulation of illness statistics almost mandatory. Without such statistics it is impossible to compute equitable illness insurance rates.

The only morbidity statistics available at the present time are the reports of preventable diseases, and practically no use is made of these statistics except for administrative purposes. This group of morbidity statistics owes its origin to the efforts of health departments to control the acute contagious diseases. It was evident to those interested in the control of these diseases that knowledge of the presence of such diseases must be acquired in order to take the necessary measures to control them and to prevent their spread through isolation, vaccination and immunization. With the advent of active campaigns against pulmonary tuberculosis this disease was added to the list of reportable diseases. As our knowledge of etiology expanded through bacteriological studies still other diseases were added to the list.

The degree of completeness attained by various communities in the reporting of contagious and communicable diseases varies and if the degree of completeness of the registration of births may be accepted as an index of the efficiency of a registrar, so too the completeness of the registration of communicable diseases may be accepted as an index of the efficiency of a health officer. It is evident a health officer cannot efficiently control the incidence of these diseases in the community under his jurisdiction unless he receives prompt and accurate information of every case occurring within his district. The reporting of preventable diseases is usually provided for in the State health laws, city charters and the sanitary codes of cities and States which are based upon the said laws or charters. In few cities of the country have vigorous campaigns to secure complete registration of preventable diseases been carried on. There seems to be a reluctance on the part of the health officers to punish physicians for their derelictions in reporting these diseases. As Newsholme points out in his volume on vital statistics the reporting of preventable diseases should be made compulsory in order to relieve physicians of the criticism by their patients for reporting these diseases and to absolve them of charges of betraying professional secrecy. The reporting of these diseases having been made compulsory, the law should be strictly, impartially and vigorously enforced. The good will and coöperation of physicians in reporting contagious diseases should be given by them to health departments in return for the free laboratory service rendered them in diagnosing diseases susceptible of diagnosis by laboratory methods. Aside from the advantages accruing to the Department of Health by closer and more friendly coöperation from physicians secured in this way, it places at the disposal of physicians, scientific means of verifying diagnoses and of doing so at an earlier period than would be possible without such laboratory assistance.

In most States the plan of reporting notifiable diseases is to have the physicians notify the health officer of the locality in which the case occurs. This officer, in turn, is required to transmit a copy of the report to the State Department of Health. In many of the large cities such as New York where the Health Department is not under the jurisdiction of the State Department of Health there is no provision for the transmission of reports to the State Department, except in the form of a summary at the end of each month. In many other than cities of the first class the wisest plan is to follow the same procedure in enforcing registration of preventable diseases, as was outlined in the chapter on the enforcement on the registration of births.

Since it is essential that there be uniformity in all statistics in order that they may be comparable it is desirable that a model law similar to the model law for the registration of deaths and births be provided and submitted to the various States for enactment.

Uses of Reports.—While the reports of preventable diseases have been of greatest value in controlling the diseases reported, but little time or energy has been devoted to the careful and scientific study and analysis. The city of Boston some time ago adopted a system of tabulating the reports of the preventable diseases by means of electric sorting devices. The city of New York is about to adopt a similar system whereby it will be possible to approach the matter from a broader point of view and to analyze the etiology of these diseases in a more intensive manner. Information that would be of inestimable value in the control of venereal diseases could be obtained from the reports of these diseases were they available.

Occupational Statistics.—The attention of the health officers and of those interested in public health work has within recent years been focussed upon the diseases caused by occupation and upon industrial accidents. The outcome of this interest has been the enactment of laws requiring that occupational diseases and accidents be reported either to the State Health Department or the State Factory Department. These reports furnish a fund of valuable information if they are but properly segregated, tabulated and analyzed. Probably no other country in the world is so wasteful of its man power and of human life as is the United States.

With the advent of pure food legislation it became compulsory in many communities within the United States for persons engaged in the handling of food products, particularly, bakers, cooks, etc., to be examined twice a year to determine their freedom from communicable diseases. The results of these examinations supply another source of morbidity statistics of which little use has been made up to the present time. The establishment of occupational clinics wherein persons suffering from diseases to which they had been exposed by reason of their occupation, has furnished us with another source of very valuable statistical information. Isolated studies of these statistics have been made by progressive health officers but there is as yet no universal scheme of handling these valuable data.

The examination of school children by physicians and nurses in the employ of the Department of Health or the Department of Education, as the case may be, has resulted in the accumulation of a vast store of very valuable information, of which, up to the present time, but little practical use has been made except in solving the immediate administrative problems presented. The employment of physicians and nurses by large industries to safeguard the health of the employees of these industries has been a great step forward in the control of illness, but up to the present time no universal system for the collection, tabulation and analyses of these statistics have been adopted. Such a system was devised and urged in this city several years ago by the authors but up to the present time no headway has been made.

One of the most recent methods of measuring community illness is the illness census. As the name implies it is a census of persons ill on a given day. Three such censuses have been taken within the last year and a half by the New York City Department of Health, and several have been taken in the different parts of the country by the Metropolitan Life Insurance Company. These censuses furnish very important and valuable information as to the amount of illness prevalent at the time of the census, but they have the shortcoming that they are but snapshots of conditions at a particular time. To make use of a rather crude simile, a census of this kind is but a "snapshot" and not a "movie."

Statistical Errors to be Avoided.—Quetelet laid down four principal rules for avoiding statistical fallacies and if the health officers will hold them in mind they will not fall into grievous statistical errors:

1. Never have preconceived ideas as to what the figures are to prove.
2. Never reject a number that seems contrary to what you might expect merely because it departs a good deal from the apparent average.
3. Be careful to weigh and record for all the possible causes of an event, but do not attribute to one what is really the result of a combination of several.
4. Never compare data which have nothing in common.

In the previous chapters we have called attention to several of the more common statistical errors but for the purpose of reference it may be well to group the more common causes of error in one chapter.

Population.—Since population is the basis upon which the presentation of all vital statistics depends we shall consider it first. Inaccurate estimates of the population are a frequent source of error. The further removed the period for which the population is estimated is from the date of the census the greater is the liability of error. This is particularly true in a newly settled community, where the increase in population depends more upon immigration than upon the excess of births over deaths. In a case where the estimate of the population is doubtful precaution should be taken to check the estimate by various methods. The following means suggests themselves: Comparison of estimate with the registration rolls of the Board of Election;

the number of inhabited houses multipled by the average number of persons per house as obtained at the previous census; school registration will furnish another check inasmuch as it gives the number of children at school ages and if we assume that children make up the same percentage of the total population as at the last census we can readily estimate the total population from the school population. Still another method of value is to ascertain the birth-rate at the last census and upon the assumption that the birth-rate remains fairly constant estimate the population in any post-censal year by multiplying the births reported for the year by 1000 and dividing by the birth-rate of the last census year.

Registration for selective service in the army and navy may be used as a basis for estimating the total population of a city, State or nation.

In comparing rates, whether death-rates, birth-rates, marriage-rates or sickness-rates, care must be taken to make allowances for difference in the sex and age constitution of the population groups whose rates are compared. We have shown in the previous chapters how the difference in the age and sex constitution of a population effects its mortality, its illness and its birth-rates. When comparing the mortality-rates of different occupational groups this source of error must be guarded against because the average age of persons engaged in different occupations varies within wide boundaries and as death-rates vary from year to year of life it is at once apparent that this difference in age constitution will, aside from all other influences, cause a marked diversion in the rates for the occupational groups under observation. There are two methods of correcting errors due to differences in age constitution: (1) By means of corrected or standardized death-rates; (2) by the use of life tables.

Errors from Paucity of Data.—One should guard against making sweeping deductions upon insufficient data. When cases or observations are inconsiderable in number or the time of exposure short, deductions are of questionable value except in certain instances; for example, it is perfectly proper to compare the death-rate of the same community for one week with the previous week or to study weekly rates of the same community week after week; but it is statistically improper to compare the weekly mortality of two different communities for so short a period as one week, especially if one is a large, the other a small, community.

Percentages.—The use of percentages in the presentation of statistical facts should be avoided except in certain instances where it is not possible because of the absence of necessary data to compute rates. The reason that percentages are an unsatisfactory medium for the presentation of statistical facts is that if a certain group of facts or observations are stated as a percentage of a whole the percentage of this group under observation will depend upon the size of the other groups as well as upon its own size. For example, if in a group of 1000 infants there were 25 deaths from diarrheal diseases and 75 deaths

from all other causes the percentage of deaths from diarrheal diseases would be 25 per cent.; if in the same group of 1000 infants there were 25 deaths from diarrheal diseases and 125 deaths from all other causes then diarrhea caused but 16 per cent. of the total number of deaths, notwithstanding the fact that the number of deaths from diarrheal disease remained the same and the death-rates based upon the number of deaths from this cause and the total number of infants under observation would be the same in both instances.

Errors from Compounding Death-rates.—The death-rates of a community cannot be obtained by finding the numerical average of the death-rates of the different boroughs or wards of that community. For example: If the death-rate of the Borough of Manhattan was 9.11, the borough of the Bronx 8.97, the borough of Brooklyn 9.31, the borough of Queens 12.21, and the borough of Richmond 13.34, the death-rate of the city would not be 10.59 but 9.45 because the populations in which the deaths occurred are not the same in all boroughs. Therefore, the death-rate of the borough of Manhattan would exert a greater weight in the death-rate of the city than would the death-rate of the borough of Richmond where the population is small. Of course, it is possible by weighting the different rates to obtain a weighted average closely approximating the true death-rate of the city, but it is far easier to compute the death-rate for the entire city upon the total number of deaths and the total population.

Errors Due to Difference in Classification.—In making comparisons between mortality of any disease in the same community for a period of years or in making comparisons of mortality of diseases in different communities for the same period great care must be exercised to make corrections for differences in methods of classification. Even when comparing statistics classified according to the international classification we must include in our comparison all diseases of each group. Perhaps we may make our point clearer by concrete examples. Some time ago while making a study of pulmonary tuberculosis in foreign and native cities we encountered a foreign city with an exceptionally low tuberculosis rate, so low in fact that it aroused suspicion as to its correctness. Upon examination of the complete mortality returns of this city we found that its death-rates from bronchitis, bronchial asthma and pulmonary hemorrhage were excessively high and that if we included the deaths from these causes as given in its report and also included the deaths from these causes as stated in the reports of the other cities under comparison we found that the combined mortality of tuberculosis and other diseases of the respiratory system was higher in the community that boasted of the low tuberculosis rate than in most of the other communities under consideration. Another example: If comparison is made of the mortality of apoplexy during recent years with past years it will be found that mortality from this cause has declined tremendously, but if we examine the statistics more closely we will find that this decrease has been in large measure caused by more careful assignments and consequent

transfer of deaths to other assignments. In other words, since apoplexy is the closing incident of arterial sclerosis, Bright's disease and chronic endocarditis, our comparison should be based upon the mortality of all these diseases and not upon the mortality of anyone of them. Another example is to be found in the statistics of typhoid fever. In early years many cases of typhoid fever were diagnosed as typho-malaria, etc., therefore, deaths from these causes as well as from typhoid fever should be included in any statistics upon which comparisons are to be made. Similarly in making up statistics for a series of years from cancer care should be taken to include all titles under which deaths from cancer might be classified. The titles under which many deaths from cancer are to be found is that of "tumors."

In comparing the mortality of diseases of infancy we must be careful to include in our statistics all the titles under which deaths might be classified. In the past many deaths which are now classified as gastro-enteritis were formerly classified under dysentery, cholera nostras and similar titles, and deaths that are now classified under the heading of prematurity, malnutrition, etc., were formerly classified under the title of "ill-defined causes." Another common source of error is to be found in the statistics of deaths from accidental poisoning by illuminating gas and accidental drowning. The error in these two causes is that in many deaths from both causes the coroner or medical examiner is unable to determine from the evidence at hand whether the death was accidental, suicidal or homicidal and consequently he reports the death as due to illuminating gas poisoning or drowning, as the case may be, without qualifications and since there is no provision made for a separate classification title for these deaths, they are perforce included in the deaths from accidents, therefore in comparing the statistics of suicides by illuminating gas one should bear in mind that the diligence of the medical examiner in ferreting out evidence is an important determining factor in the mortality from this cause. The same is true in the statistics of drowning, both accidental and suicidal.

GEOMETRICAL METHOD OF ESTIMATING POST- AND INTERCENSAL POPULATIONS.

The arithmetical method has been explained in the previous chapter and in it the assumption is made that the annual increase or decrease in population as ascertained by comparison of the figures of the populations obtained in the last two enumerations or censuses maintains during the years between the censuses and those succeeding the last census year. The *annual increase or decrease* is the *same* during each year and may be compared to a sum in simple interest.

The geometrical method, on the other hand, assumes that the *same rate of increase* maintains as occurred in the previous intercensal period and that the amount of annual increase is in proportion to the

population, thus taking cognizance of the annual increase of persons of marriageable ages and consequently the annual increase in the number of parents and of living born children. The geometrical method is the one employed by European statisticians and has given more approximately correct estimates in the experience of the city of New York, in which the natural increase in the population remains fairly constant. It is evident that according to this method the calculations are similar to those in computing compound interest.

Let r equal the annual rate of increase per unit of the population; then each unit at the end of the first year will equal $1 + r$; at the end of the second year $(1 + r)^2$ and so forth. Let P represent the population at the beginning of the first year, which at the end of the first year will equal $P\ (1 + r)$, at the end of the second year, $P\ (1 + r)^2$ and so forth. The value of r can be ascertained from the populations at the two last censuses.

If P = the population in 1900 and P^1 = the population in 1910, then $P^1 = P\ (1 + 4)^{10}$.

Taking the logarithm of each side of the equation we have: $\log P^1 = \log P + 10 \log (1 + r)$.

Transposing: $\log P^1 - \log P = 10 \log (1 + r)$, $\log (1 + r) = \frac{1}{10} (\log P^1 - \log P)$.

From a book of logarithms the value of $1 + r$ is readily obtained. It must be remembered that the population at the middle of the year is always taken as the basis of calculation of mortality-rates, thus making it necessary to make estimates of the mid-year population even in a census year.

Specific and Standardized Death-rates.—A perusal of what has been said in relation to death-rates furnishes a basis for a more detailed procedure to be adopted in making comparisons of the crude death-rates of various cities or countries. It can be readily grasped that specific death-rates, that is, rates from certain specified causes or at specified ages may be quite readily compared with those of other communities. The infant mortality-rate based upon 1000 births in a city may be compared with that of any other city without the necessity of applying corrective methods; so may the death-rate of children under five years of age be compared with a similar rate in various communities and so may the death-rates at any age or any age group as occurring in one community, city, State or country be compared with those of other communities.

The death-rate per 1000 of the entire population from certain causes of death occurring at and limited to certain age groups may be safely compared with similar rates in civilized communities, as for instance the death-rates from measles, scarlet fever, diphtheria, whooping-cough and diarrhea. On the other hand, the comparison of crude death-rates as experienced in one community with those of another are likely to lead to erroneous conclusions. Hence, if the age constitution of the population of one city, State or country is radically dissimilar to that of any other city, State or country the crude death-rate

of the one cannot with justice be compared with that of the other. An example will best show the truth of this statement: Suppose the cities A and B have exactly the same death-rate at the four specified age groups in the table and exactly the same total number of residents but with dissimilar age groupings of the populations.

Population.	A.	Death-rate per 1000.	No. of deaths.	B.	Death-rate per 1000.	No. of deaths.
Under 1 year	1,500	100	150	1,000	100	100
1 to 19 years	20,000	20	400	20,000	20	400
20 to 49 "	15,000	15	225	20,000	15	300
50 and over	13,500	60	310	9,000	60	540
Total	50,000		1,585	50,000		1,340

Crude death-rate A = 31.70. B = 26.80.

It is thus seen that the difference of 4.9 points in the rates is the result of the dissimilar age grouping of the two populations, and of that alone, and that the crude death-rate does not furnish a just measure of comparison among communities unless the age distribution is substantially the same, or unless means are taken to allow for the varying age constitution of the populations. On the other hand there is no good reason why the crude death-rate may not be used in comparison of the mortality of a community with that experienced by the same community during a series of years unless the age distribution has materially changed; nor is it to be discarded as a standard of comparison for two or more communities the age groupings of whose population are substantially similar.

To eliminate the effect on the crude death-rate of the differences in the age distribution of populations a standard population must be adopted. The International Statistical Institute, in 1895, adopted an "Index of Mortality," based on the recommendations made by Dr. J. Körösi. This procedure consists in the application of the death-rates of five age groups in any community or country to the population of Sweden as ascertained at the census of 1890, the age grouping as shown in this census being known as the "Standard Population."

The following is an example of the method used:

DEATH-RATE OF NEW YORK CITY, YEAR 1911. STANDARDIZED BY APPLICATION OF DEATH-RATES AT AGE GROUPS TO STANDARD POPULATION OF SWEDEN.

Standard population of Sweden.		Death-rate by age groups, New York City, Year, 1911.	Standardized death-rate, New York City.
Age groups.	Percentage by age groups.		
Under 1 year = 26,500	0.0265	95	2.617
1 to 20 years = 398,100	0.3981	11	4.379
20 to 50 " = 386,200	0.3862	6	2.317
50 years and over = 189,200	0.1892	40	7.568
Total = 1,000,000			16.881

As the death-rate under one year of age was 95 per 1000 living at that age and the percentage of the population under one year was 2.65 the number of deaths per 1000 at that age group will be $95 \times 0.0265 = 2.617$; the rates at the other age groups are worked out in similar manner and the sum of the rates will be 16.88 per 1000 of the entire population. As the calculated rate for the year 1911 was 15.30 then the standardized rate was 1.58 points higher than the crude rate, thus showing that the age distribution of the city of New York was favorable to that extent as compared with that of the standard population. The correction or standardization of the crude rate of New York City by this method applies only to age distribution of the population.

The standard population of any other country may be used rather than that of Sweden if so desired.

The population of England and Wales as taken in 1901 has been used as a standard population by the Registrar-General for many years, eleven age groups by sex being employed beginning with the group under five years of age and ending with the group seventy-five years of age and over, thus making correction not only for age but also for sex constitution of the population. A detailed application of the method employed in the Registrar-General's office is to be found in Newsholme's *Vital Statistics* published in 1899 to be had at the Macmillan Company, New York.

Graphic Presentations.—A graph is a visual presentation of quantitative data in such form that he who runs may read.

Graphs possess the following advantages over tabulated figures: (1) They save the time of the reader; (2) they usually take up less space than the tabular statements; (3) they aid materially in allowing the reader to form his own deductions rather than have them formed for him by the person analyzing the figures; (4) they leave impressions on the mind more lasting than the figures themselves.

The graphic forms most used are bars, circles, curves, maps, charts, quadlilstivals and cubes. The simplest form of a graph is the horizontal bar and gives excellent results in showing the component parts of a total. The groups may be distinguished one from the other by divisional lines, by various shadings or by color, the latter being the most expensive. The circle with its sectors is also much used in showing component parts, but does not appeal as quickly to the eye as the horizontal bar, the component parts are more difficult of comparison and the direction of the lettering, especially if the sectors are of small dimension, are not horizontal. Vertical bars are often used with good effect in showing death or rates through a series of years. Curves may be drawn by lines connecting the tops of the vertical bars or may be constructed without actually drawing the bars. Curves are used frequently in vital statistics and are preferable in many instances to the vertical bar arrangement.

Pin maps are frequently made use of to show location of illness and mortality by selected areas. Small glass beaded pins of varying colors stuck their full length into boards made of soft wood or straw serve best.

RULES TO BE OBSERVED IN PREPARING CHARTS.

1. Title of chart should state clearly the subject matter and the duration of time, location or other modifying factors; wall charts should be so lettered and numbered as to be legible at usual visual distances.

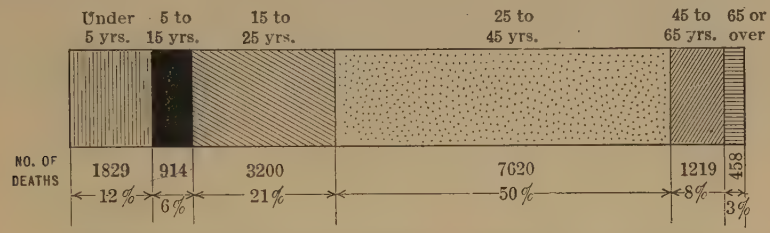

FIG. 118.—Deaths from Influenza and Pneumonia by age groups and percentage of total deaths from these two causes. Autumn 1918, City of New York.

2. Figures for the horizontal scale should be placed at the bottom of the chart, but if large variations in height occur the figures may be placed on the top as well as the bottom of the chart and should read from left to right.

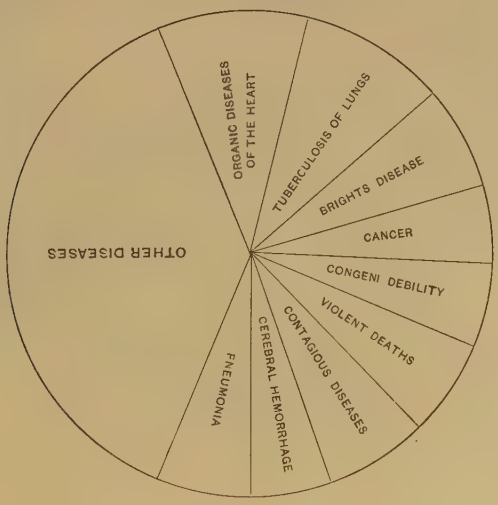

FIG. 119.—Deaths in registration area in United States, 1911. Percentage of deaths from specified causes: Organic disease of heart, 10; tuberculosis of lungs, 9.7; Bright's disease, 6.9; cancer, 5.2; congenital debility, 5.6; violent deaths, 6.4; contagious diseases, 6.9; cerebral hemorrhage, 5.4; pneumonia, 6.3; other diseases, 37.6.

3. The general arrangement should be from left to right.

4. Figures for the vertical scale should be placed both on left and right sides of the chart and should read from bottom to top.

5. Numerical data should be given on the chart if possible and if not should be printed in close proximity thereto.

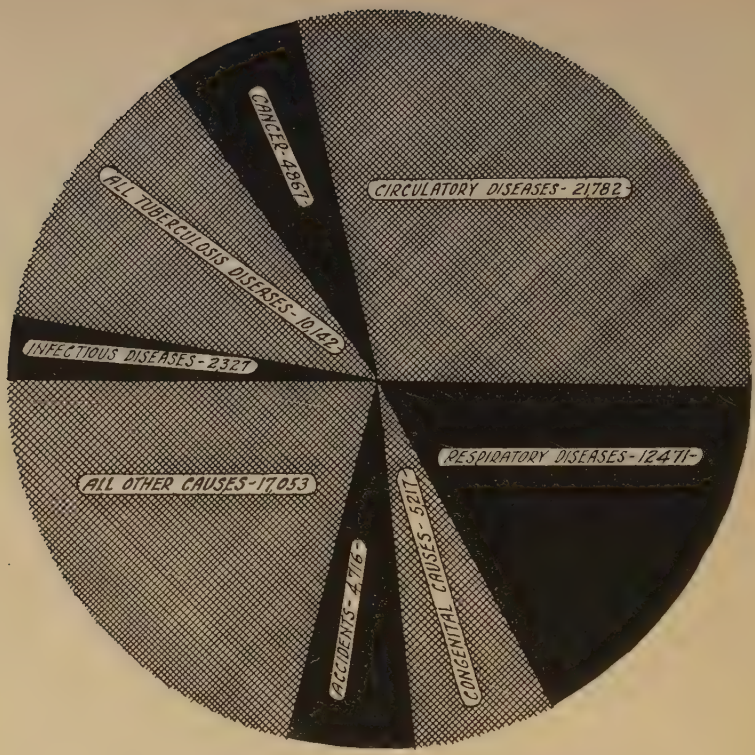

FIG. 120.—City of New York. Deaths from certain causes, year 1917. Total deaths from all causes, 78,575.

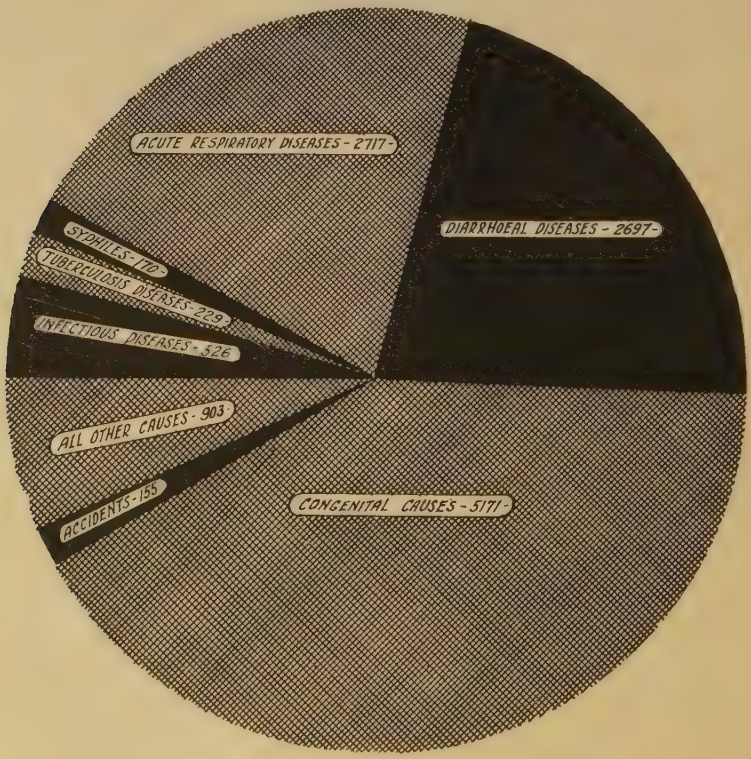

FIG. 121.—City of New York. Deaths of children under one year of age from municipal causes, year 1917. Total deaths of all causes under one year, 12,568.

6. Curves should be made of broader lines than the coördinate lines.

7. The zero line should be shown whenever possible and should be a line heavier than the coördinate; if dimensions of the chart are such

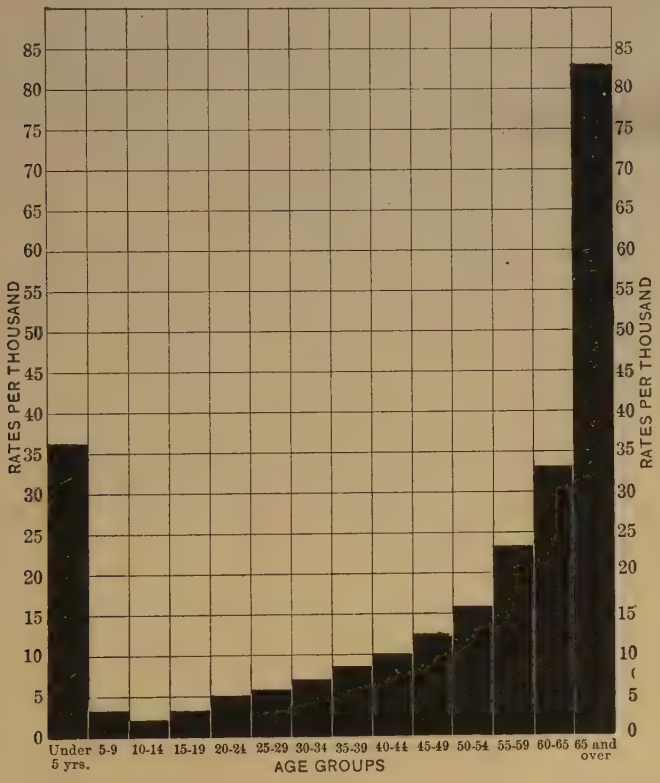

FIG. 122.—Death-rates by age groups, years 1909, 1910 and 1911. Original registration States, United States.

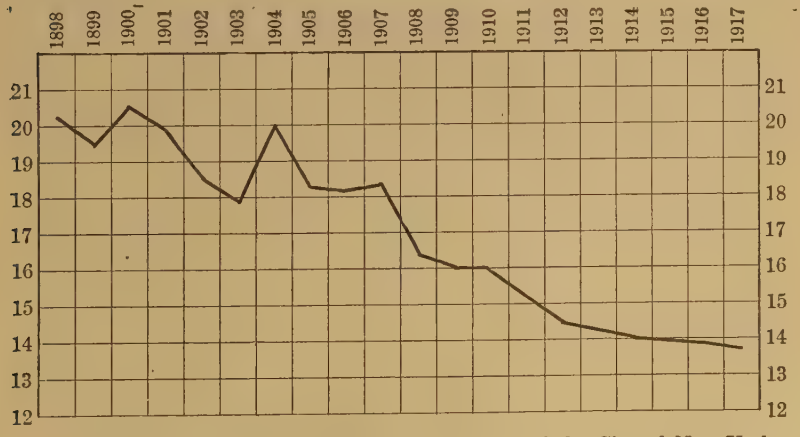

FIG. 123.—Crude death-rate per 1000 of population of the City of New York, 1898–1917 inclusive.

that it cannot be shown then a broken or wavy line should be used to show the incompleteness of the field.

8. The variable line or curve should be shown as proceeding in a horizontal direction.

9. In comparing curves the scales of each must be identical.

Fig. 118 is a good example of the use of the horizontal bar.

Fig. 119 is shown as an extremely bad example of the use of the circle as the data have not been placed within its boundary and as the eye can only grasp the various causes of death shown by movement of the chart.

Figs. 120 and 121 are good examples of circular graphs, especially Fig. 121 by reason of its clearness of reading.

Fig. 122 is a good example of the vertical bar arrangement in showing death-rates at various age groups.

Fig. 123 is a good example of a curve, showing the crude death-rate for a period of twenty years.

ADDENDA TO CHAPTER III.

The following sections were inadvertently omitted from Chapter III:

TRENCH FEVER.

A disease characterized by febrile relapses became very prevalent in the different European armies during 1915 and continued until the end of the war; it caused a great amount of disability. Its etiology was studied by British and American Commissions. It is believed that outbreaks of a similar character appeared previously in armies and among crowded populations, but there is no conclusive proof. The symptoms are not sufficiently characteristic to identify individual cases.

Trench fever is due to a resistant filterable virus which is present most abundantly in the plasma of the blood and to a less extent in the urine, sputum and possibly feces. It is transmitted naturally by the infected body louse, Pediculus humanus. The louse is itself infected by having previously fed upon an infected person. The eggs of the infected louse are apparently uninfected. The feces of the infected louse carry the contagion and when rubbed into a wound may transmit the disease. The same is true of the sputum and urine of infected persons.

Prevention.—All infected persons should be disinfected as soon as possible by careful bathing and sponging with alcohol. The personal clothing and bed clothing should be disinfected by exposure to moist heat at 70° C. for one-half hour. Trench fever patients should be protected from louse infestation. In general, all practical means should be used to lessen louse infestation of the people.

ENCEPHALITIS LETHARGICA.

Within the past two years this disease has attracted much attention; it probably has existed for a long time.

The work of Loewi and Strauss indicates that the disease is due to a filterable virus which is found in the central nervous system and also in the secretions of the nasopharynx. It is possible to transmit an infection to monkeys and rabbits when this material is injected intracerebrally. Levaditi independently, but at a later period confirmed this. Loewi and Strauss believe that a virus similar in form to that isolated from poliomyelitis is the cause of the disease. Levaditi and Amoss have failed to obtain cultures and Amoss was unable to infect animals. It is hoped that further investigations will clear up these differences.

Prevention.—While few if any cases have a clear history of infection, the disease is in all probability spread in the same way as poliomyelitis. Many persons probably become carriers, and of these only an occasional one contracts the disease. All discharges and especially those from the mouth and nose should be disinfected,

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